ANNALS

OF THE

ASTROPHYSICAL OBSERVATORY

OF THE

SMITHSONIAN INSTITUTION

VOLUME V

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ASTROPHYSICAL OBSERVATORY
WASHINGTON, D. C.

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VOLUME V

By

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PREFACE

The present Volume V of the Annals of the Astrophysical Observatory covers about a decade of its operations. These have taken on a new phase, marked by the continuous operation of its field stations. Great public interest was aroused in previous studies which seemed to indicate substantial variability in the output of radiation from the sun. There seemed to be a probability that these changes of the energy available to warm the earth might bring important consequences to weather and other terrestrial concerns. It appeared incumbent on the Astrophysical Observatory to maintain the most accurate possible daily record of the solar radiation, in order to detect and measure its variations.

This has led to the continuous occupation of Mount Montezuma in northern Chile, the establishment of an observatory on Mount Harqua Hala, Ariz., afterwards removed to Table Mountain, Calif., and, in cooperation with the National Geographic Society, the establishment and operation of a station on Mount Brukkaros, Southwest Africa. Diligent observing at all of these desert mountain observatories has yielded a great number of data. These it has been the province of the central station at Washington to study and reduce to a consistent series. In the meantime, several expeditions to Mount Wilson have contributed results of interest related to the problems of solar and stellar radiation.

The personnel in Washington and in the field have worked loyally to advance the operations. Deserving special mention are—

At Washington: Mr. A. Kramer, instrument maker to the observatory for almost 40 years; Mrs. A. M. Bond, computer, 1918–1928, statistical assistant since 1929; Miss M. Marsden, computer, 1926–1929; Miss M. A. Neill, secretary since 1919, whose careful attention to records and publications has been invaluable.

In the field: Messrs. A. F. Moore, H. B. Freeman, H. H. Zodtner, W. H. Hoover, and L. O. Sordahl, field directors; and Messrs. F. A. Greeley, E. E. Warner, M. K. Baughman, C. P. Butler, assistants. Messrs. A. F. Moore and F. A. Greeley are long-experienced field men. Mr. Moore began field directing at Hump Mountain, N. C., in 1917; set up and directed stations at Calama and Montezuma, Chile, 1918–1920; directed at Mount Harqua Hala, Ariz., 1921–1925; and set up and directed the station at Table Mountain, Calif., 1925–1930. Mr. Greeley was assistant at Mount Harqua Hala, 1920–1923; continued at Montezuma, Chile, 1923–1926; went as assistant to Mount Brukkaros, Southwest Africa, 1926–1929; and was assigned to Table Mountain, 1930.

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VOLUME V

INTRODUCTION

SPECIAL INVESTIGATIONS

That the reader may have before him a fairly complete picture of the long research on solar radiation in which the Astrophysical Observatory has been engaged, it will be well to summarize the results published in previous volumes of these Annals. The object of the observatory is well expressed in the following quotation from Volume II:

> The Astrophysical Observatory of the Smithsonian Institution was founded through the efforts of the late Secretary Langley, who was its director until his death. The research described in the present volume is a continuation of the work on the relations of the sun to climate and life upon the earth, of which he was a brilliant pioneer investigator.
>
> Mr. Langley expressed the hope that careful study of the radiation of the sun might eventually lead to the discovery of means of forecasting climatic conditions for some time in advance.

He stated the vision he had for the observatory in the following words: [1]

> If the observation of the amount of heat the sun sends the earth is among the most important and difficult in astronomical physics, it may also be termed the fundamental problem of meteorology, nearly all whose phenomena would become predictable, if we knew both the original quantity and kind of this heat; how it affects the constituents of the atmosphere on its passage earthward; how much of it reaches the soil; how, through the aid of the atmosphere, it maintains the surface temperature of this planet; and how, in diminished quantity and altered kind, it is finally returned to outer space.

The early work of the Astrophysical Observatory, as published in 1900 in Volume I of its Annals, consisted in developing delicate recording measuring instruments and in their application to the mapping of the lines of solar and terrestrial absorption in the infra-red solar spectrum. A particularly accurate and well-appreciated part of this work consisted in the determination of wave lengths and indices of refraction for spectra produced by prisms of rock salt and fluorite.

After observing on a rather large scale the total solar eclipse of May, 1900, at Wadesboro, N. C., as described in a special publication of the observatory,[2] attention

[1] Langley, S. P., Researches on solar heat and its absorption by the earth's atmosphere. A report of the Mount Whitney Expedition. Professional Papers of the Signal Service, no. 15, p. 11, 1884.

[2] Langley, S. P. A preliminary account of the solar eclipse of May 28, 1900, as observed by the Smithsonian expedition. Annual Report of the Smithsonian Institution 1900, pp. 149–155, 1901.

was more closely directed to Langley's great problem. The march of the investigation is summarized in the following quotation from Volume IV of the Annals:

Since the year 1902 we have carried on at the Astrophysical Observatory an investigation of the general question of the dependence of terrestrial affairs on radiation. There are two branches of this study. First, that relating to the incoming rays from the sun; second, that relating to the outgoing rays from the earth. Progress in both branches of the investigation requires suitable instruments. Volumes II and III of these Annals and numerous articles published in scientific periodicals and in the Smithsonian Miscellaneous Collections contain accounts of progress and descriptions of new forms of apparatus devised for the work.

In Volume II of the Annals, published in 1907, the first part gives an account of the work on solar radiation, the methods employed, the sources of error encountered, a description of the instruments in use at the time, and the results of two years of investigation upon Mount Wilson and five years of investigation at Washington of the intensity of the solar radiation. In this investigation evidences of variability of the sun were indicated. This variability was of irregular interval and ranged apparently through a maximum of 10 per cent. The second part of the volume includes some measurements of the light of the sky, the reflection of clouds, and a discussion of the balance of energy between the incoming rays from the sun and the outgoing rays from the earth, including an investigation of the reflecting and radiating power of the latter. Part 3 gives results of work in Washington on the distribution of radiation over the solar disk.

Volume III of the Annals, published in 1913, relates almost wholly to solar-radiation measurements. Improved methods and improved apparatus were described, including special apparatus for measuring the intensity of the solar radiation as a whole. The scale of measurement was definitely fixed so that the intensity of the solar rays could be expressed in calories per square centimeter per minute within an error thought to be less than half of 1 per cent. Results of observations at Mount Wilson from 1908 to 1912 were given and these still indicated the variability of the sun's rays outside our atmosphere, notwithstanding that improved methods of observing had diminished the probable inaccuracy of the work. What might before have appeared as possibly due to accidental error now seemed to be certainly caused either by changeability in the atmosphere or by actual changes in the sun. By means of simultaneous observations at Mount Wilson and Mount Whitney (the latter being the highest mountain in the United States) it appeared that the altitude of the observer, at least between sea level and 4,420 meters, played no part in altering the values obtained for the intensity of radiation of the sun outside the earth's atmosphere.

In order, however, to fully establish the solar character of the variations encountered, and to show that they existed independently to terrestrial influence, expeditions were made to the station at Bassour, Algeria, in the years 1911 and 1912. The results of observations for more than 50 days at both Bassour and Mount Wilson indicated that if high values were found at one station, high values would be found at the other and vice versa. Thus it made no difference in what quarter of the world the observer located himself, he found on the same days similar indications of solar variability, so that the conclusion is strongly confirmed that these variations exist in the sun itself and are not due to errors either of terrestrial atmospheric conditions or accidently introduced by the instruments themselves.

The mean value of the solar constant of radiation, as determined by the work from 1902 to 1912, was found to be 1.933 [3] calories per square centimeter per minute. The variations of the sun were found to be not only of short periods of a few days but also to range over several per cent in the course of years, and to show correlation with the periodicity of sun-spot activity upon the sun's disk. During the year 1912 the ground-level observations at Mount Wilson and at Bassour showed the powerful influence of the great volcanic eruption at Mount Katmai in Alaska, which occurred on June 6, 1912. On June 19 the sky became slightly turbid in Bassour and a day or two later also at Mount Wilson. The milkiness increased rapidly and became very apparent, so that in July, and still more in August, a thick haze overspread the whole sky and cut

[3] A slight error occurred in publishing this value in Vol. III, where it is given as 1.932 calories.

off more than 20 per cent of the sun's direct radiation at noontime. Nevertheless the "solar-constant" values were not very abnormal despite these extraordinary atmospheric conditions.

Values of the atmospheric transparency at Washington, Mount Wilson, Mount Whitney, and Bassour for average days, for very clear days, and for very hazy days, were tabulated. The form of the solar-energy curve outside the atmosphere was given as the result of many days of observation in many different years with a variety of instrumental equipments. Some of these observations were made at Washington, others at Mount Wilson, and still others at Mount Whitney. From these results estimates were formed of the probable temperatures prevailing in the sun.

Small attention was given to the terrestrial side of the problems, but a summary was given of measurements of sky brightness at several stations.

Improved methods of reduction of the observations of 1907 made at Washington on the distribution of radiation over the sun's disk were described and tabular values given for many wave lengths.

The Appendix of Volume III contains a bibliography of the principal papers published by the staff of the observatory and reprints of several of them.

After this followed the work described in Volume IV of the Annals, of which we quote the Summary from pages 319, 320 of that volume.

The principal features of the present volume are as follows:

1. The continuation for nine years of investigation of the intensity of solar radiation, as it is at the earth's surface, and of its intensity outside the atmosphere.

2. New determinations of the solar constant of radiation by two methods, that of Langley, based on high and low sun observations of homogeneous rays carried through about 1,300 times at three stations since 1912, and that of observing the sun's total radiation at altitudes progressively higher and higher, from sea level to high mountain stations and up to 25,000 meters as reached by sounding balloon observations in 1914.

3. Further tests of the errors of solar-constant observations by the method of high and low sun, including besides theoretical and statistical studies, two successive days of spectrobolometric work from the moment of sunrise till nearly noon, with air masses ranging from 18.8 to 1.3.

4. The installation and prosecution for eight years of observations of the distribution of radiation over the sun's disk.

5. The establishment of additional solar radiation stations at distant points for the purpose of checking and confirming the evidences of solar variability.

6. The introduction of a new short method of solar-constant determinations based on the Langley method of high and low sun, but requiring only 15 minutes for all the observations.

7. The comparison of the independent results of far-separated stations, and the correlation with solar-constant values of our own studies of distribution of radiation over the solar disk, and of the observations reported by others on terrestrial temperatures and magnetism, on the number of sun spots, and on the brightness of the planets.

8. The extension of our hypothesis of solar variability to contemplate a sun radiating with variable intensity according to the prevailing solar activity, but its radiation also modified by the prevailing local obscurations of the solar envelope and constrained to give the appearance of rapid variability by the solar rotation which brings to the different heliocentric longitudes successively the rays unequally emitted in successive local solar regions.

9. The design and construction of new apparatus for solar and allied researches, including the balloon pyrheliometer, the pyranometer, the vacuum bolometer with complete mathematical theory, the melikeron or honeycomb pyranometer, and others.

10. The investigation of radiations of great wave length in their relations to transmission by water vapor, carbon dioxide, and ozone, and the relations of many common solid substances to these long-wave rays.

11. The measurement of the brightness of the sky under a great variety of circumstances.
12. The determination of the reflecting power of clouds by balloon observations.

It is found that the average value of the solar constant of radiation from 1,244 determinations in the years 1912 to 1920 is 1.946 calories (15° C.) per square centimeter per minute. This value exceeds that, 1.933, determined in the years 1902 to 1912 as published in Volume III of these Annals. This excess is attributable to the higher average numbers of sun spots which prevailed in the later period. A result indicated by the work published in Volume III is definitely confirmed, namely: Increasing solar activity as shown by increased sun-spot numbers tends toward increased solar radiation. This conclusion must, however, be modified by the effects of local obscurations of the sun's surface, which not infrequently diminish the solar constant, accompanying the passage of great sun-spot groups centrally over the sun's disk.

While the measurements have been conducted mainly at Mount Wilson, Calif., the station Calama, Chile, occupied from July, 1918, to July, 1920, by Messrs. A. F. Moore, director, and L. H. Abbot, assistant, furnished the most continuous and accurate series of solar-constant values ever observed.

These Chilean observations, telegraphed daily to Buenos Aires at the request of the Argentine weather bureau, have been employed by Mr. H. H. Clayton, Argentine chief forecaster, for several years in forecasting Argentine weather conditions. Mr. Clayton has made a great study of the dependence of weather conditions on solar variation, and believes that solar radiation studies furnish a valuable forecasting element.

With a view to test this supposed dependence of terrestrial weather on solar variations, the Mount Wilson solar-constant apparatus has been removed to a new station, Mount Harqua Hala, Ariz., and the Calama outfit has been installed on Mount Montezuma, Chile. These changes were made possible by the generosity of Mr. John A. Roebling. It is proposed to carry on the solar-radiation observations for several years on all suitable days at these cooperating observatories located, respectively, in the most cloudless regions of North and South America.

GENERAL SUMMARY

It is the continuation of this work and other investigations related thereto which forms the subject matter of the present volume.

In this volume we report the establishment and progress of several solar-radiation observatories, located on mountain tops in desert lands, whose object it is to keep a daily record, as far as possible, of the intensity of solar radiation as observed at each station and as it would be found outside the atmosphere. We describe the improvements of apparatus and the methods adapted to improve the accuracy of the results. We note the several untoward happenings at these stations which have tended to cloud, from time to time, the values obtained, and we describe the statistical investigations continued at Washington for the purpose of removing, as far as possible, all sources of error occasioned by untoward happenings and by the variable elements of the atmosphere. We cite new determinations of the distribution of solar radiation in the spectrum as it is outside our atmosphere, and the preliminary attempts made by Doctor Abbot to extend this sort of knowledge to the stars. We describe evaluations made of the energy contained in the farther regions of the ultra-violet and the infra-red spectrum not covered with accuracy by the daily solar observations. We refer to the researches of Mr. Fowle, Doctor Abbot, and Dr. Oliver R. Wulf on the ozone content of the atmosphere above certain stations, the variations thereof through the year and associated with sun-spot numbers, and the influence of these changes on the measurements of the intensity of solar radiation. We cite also the observations of Mr. Aldrich on the cooling of the human body by radiation and convection, the relation of this cooling to metabolism, and the basis it affords for inferences as to the proper design of halls of assembly. We examine the march of solar radiation over a period of more than 10 years, and call attention to its variations and to certain regular periodicities thereof. We make note of certain apparent dependences of solar and terrestrial phenomena on these variations of radiation. We draw special attention to the dependence of weather on short-interval fluctuations of the solar radiation.

Although the variability of the sun is verified by the intensive observing of this past decade, the earlier impression that solar variations frequently reached ranges exceeding 5 per cent is not supported. We incline to think the earlier impressions of a larger solar variability were founded on measurements too much affected by terrestrial atmospheric influences. A residuum of apparent variation of solar radiation remains, nevertheless, after making all possible improvements. Comparison of results of remote stations; correlations with other measurements, independently made by other observers; and especially correlations with weather changes at remote stations, all incline us to consider present indications of solar variation as largely real. Certain comparisons made with weather phenomena by ourselves and others seem to indicate that, either directly or by some indirect chain of connection, these solar changes, though so small, are nevertheless probably of importance. For they seem to be associated with weather and climate in such ways that a continued observation of them may yet discover relations on which forecasts may be founded covering considerable periods in advance. Thus the vision of Langley seems apt to be in a measure realized.

Chapter I

ANNALS

The following selections from the annual reports of the Director, state the progress of the work from the date of publication of Volume IV of these Annals to include the year 1930.

FISCAL YEAR 1920–1921

WORK AT WASHINGTON

The preparation of the manuscript for Volume IV of the Annals of the Observatory was continued. Owing to the postponement of its publication, it has required to be brought up to date by repeated additions and modifications, and it is now expected to publish in Volume IV all the results up to September, 1920, when the solar radiation apparatus which had been employed on Mount Wilson was removed to Mount Harqua Hala, Ariz. A great deal of measuring and computing was required to bring up to date the work of 1919 and 1920 on the solar constant of radiation and to work up the results of the observations of the distribution of light over the sun's disk, which have been carried on since 1916 with only partial reduction. This work went on under Mr. Fowle's direction, assisted by Mrs. Bond, computer, and for a few months by temporary computers, Miss Inez Ensign and Miss Esther Weaver. The cost of employing these computers temporarily was borne by a gift of Mr. John A. Roebling. At the close of the fiscal year the computations of the Annals had been very nearly completed. The manuscript of the volume was also almost ready for publication, and it is hoped to put the whole to press early in the autumn of 1921.

As usual, a large amount of delicate instrument work has been done by Mr. A. Kramer, instrument maker, and still more delicate parts have been prepared by Mr. L. B. Aldrich, of the observatory staff. They have prepared and standardized a number of pyrheliometers, pyranometers, galvanometers, and bolometers for the use of the observatory and its stations.

By invitation of Dr. George E. Hale, director of the Solar Observatory at Mount Wilson, Calif., Doctor Abbot has undertaken the preparation of a special spectrobolometer for the observation of the energy spectra of the stars in the same manner in which we are accustomed to observe the energy spectrum of the sun. This outfit comprises a special spectroscope, a vacuum bolometer of special dimensions and construction, and a vacuum galvanometer designed to be of the very highest order of sensitiveness. The construction of this apparatus had been almost completed at the close of the fiscal year.

REMOVAL FROM MOUNT WILSON, CALIF., TO MOUNT HARQUA HALA, ARIZ.

As stated in last year's report, by the generosity of Mr. John A. Roebling, of Bernardsville, N. J., not only has the private station of the Smithsonian Institution located near Calama, Chile, been removed to the top of a mountain about 8 miles farther south, but the station of the Astrophysical Observatory has been relocated on the mountain called Harqua Hala, situated about 100 miles to the northwest of Phoenix, Ariz. In June, 1920, Doctor Abbot selected the site for the latter station and arranged with local contractors for the erection of an adobe building about 40 feet long, 10 feet wide, of two stories. The lower story, underground, was designed for the instruments, and the upper story for a dwelling house and computing rooms for the observers. Proceeding from Arizona to Mount Wilson, Doctor Abbot was joined early in July by Mr. L. B. Aldrich, and together they carried out at Mount Wilson, in July, August, and part of September, the usual observations on the solar constant of radiation and on the distribution of radiation over the sun's disk. In addition, they conducted a number of other investigations, including a redetermination of the constants of the secondary pyrheliometers employed in the research, a redetermination of the transmission of the spectrobolometer for different wave lengths, various investigations with the pyranometer and the Ångström pyrgeometer, and, assisted by Mrs. Abbot, investigations on the use of solar radiation for cooking purposes.

SOLAR COOKER

The solar cooking outfit erected on Mount Wilson some years ago was in 1920, for the first time, brought to a reasonable degree of perfection. The mirror, which is of parabolic cylindrical shape, about 10 feet long and 7 feet wide, brings the solar radiation to focus on a tube filled with oil which passes up the axis of the mirror, parallel to the earth's axis, and about this tube, on suitable rollers, the mirror is rotated by means of a simple and inexpensive clockwork, in order that it may always face toward the sun. The oil tube is connected with a reservoir of oil about 10 feet higher up and from this a return tube goes underneath the mirror, thus completing the circuit for the flow of oil which the mirror, by focusing the sun rays, strongly heats. The reservoir contains about a barrel of oil, which is such as is used for lubricating gas-engine cylinders. The reservoir and the oil-circuit tubes are protected from the loss of heat, as far as possible, by insulation. The greatest loss of heat occurs with the naked tube which passes through the mirror. This, however, is protected by a glass tube 4 inches in diameter, and this, in turn, by flat sheets of glass covering the whole mirror and protecting it from dust and wind. Two ovens are inserted in the rear of the reservoir, which is just outside the door of the observer's cottage on Mount Wilson, and food after being prepared in the kitchen, may be baked, boiled, or stewed in these ovens, according to the character of the dish. Nearly all of the food prepared for the use of the observers during their stay on Mount Wilson, from July 1 to September 15, was cooked by this solar cooker. The great advantage of the cooking is that the reservoir stays hot for a good many hours, so that cooking may be continued through the night or even through a partially cloudy day. The apparatus proved to be especially satisfactory for the canning of fruit.

MOUNT HARQUA HALA STATION

In the early part of September Messrs. Abbot and Aldrich packed the apparatus which had been used on Mount Wilson for observing the solar constant of radiation and shipped the same to Wenden, Ariz., the nearest railroad station leading to Mount Harqua Hala. The apparatus was set up for observations by the end of September, and Doctor Abbot, with Mr. F. A. Greeley as assistant, carried on solar radiation measurements beginning October 3 continuously until January 20, 1921, when Doctor Abbot was relieved by Mr. L. B. Aldrich, who in turn was relieved by Mr. A. F. Moore, formerly director of the observatory at Calama and Montezuma, Chile, who reported for duty about April 20. It is intended to carry on the solar constant observations at Mount Harqua Hala on all days when the weather permits for several years in cooperation with the similar observations being made at Montezuma, Chile. With the results of the two stations, it is hoped to furnish a sound basis for the study of solar variation and the dependence of terrestrial weather conditions thereon. The station at Mount Harqua Hala was erected after a considerable investigation by the United States Weather Bureau of sites in California, Arizona, and Nevada. From the middle of September, when Messrs. Abbot and Aldrich arrived in the vicinity, until some time in February the conditions were found to be superior to what had been expected. About 70 per cent of the days during that interval were fit for observation. The months of March, April, and May proved to be less satisfactory than was anticipated, owing to a thick haziness and much cirrus cloud. This defect, however, seems to be attending the generally unusual character of the weather in large areas of the globe. During the first four months of the year 1921, for instance, hardly more than half of the usual number of observations were made at the station in Chile, and other facts might be cited which would tend to show that the earlier part of the year 1921 was of very unusual character from a weather standpoint.

The station on Mount Harqua Hala, being 15 miles from Wenden, the railroad station, and 5 miles from a wagon road, is very isolated. The effect of such isolation on the morale of observers was very thoughtfully considered by Mr. John A. Roebling, and he added considerably to his first gift in order to provide a great many things for the comfort and recreation of the observers, both in Arizona and South

America. Not all of these arrangements had been completed at the close of the fiscal year, so that mention of them may be deferred more properly to next year's report.

PERSONNEL

Miss F. A. Graves resigned as computer on August 10, 1920.

SUMMARY

The year has been marked by the transfer of the solar-radiation measurements from Mount Wilson, Calif., to Mount Harqua Hala, Ariz., to secure more perfect weather conditions. It is intended to continue solar-constant observations there daily when possible throughout the entire year for several years. Similar duplicate observations are to be carried on at Montezuma, Chile, at the private station of the Smithsonian Institution. Thus it is hoped to provide an excellent basis of solar-radiation measurements to compare with weather phenomena. This may lead to advance in methods of weather forecasting. Volume IV of the Annals, covering the years 1912 to 1920, is practically ready for the press.

FISCAL YEAR 1921–22

WORK AT WASHINGTON

The director, with Mr. Fowle and Mrs. Bond, was engaged much of the year on the preparation and proofreading of Volume IV of the Annals of the Observatory. This quarto volume of 390 pages, including 60 illustrations and 118 pages of numerical tables, covers the work of the years 1912 to 1920, and was published in June, 1922. New apparatus and methods of observing are described and illustrated, and a large mass of solar observations is presented and discussed. Evidence is given of many kinds which indicates the solar variability. Reference is made to applications of the results which have been made by several meteorologists.

In preparation for work proposed for the expedition to Mount Wilson in the summer of 1922, Mr. Aldrich, in consultation with the director, prepared the sensitive parts of a galvanometer and a vacuum bolometer of usual types for solar work, and also of a vacuum galvanometer and vacuum bolometer of very unusual design suited to observing the energy distribution in the spectra of the stars. These extremely delicate and sensitive instruments required extraordinary skill and patience for their construction and testing. Acknowledgments are due the Director of the Bureau of Standards, the Director of the Nela Research Laboratory, and also Dr. Elihu Thomson, of Lynn, for aiding these preparations.

The instrument making for these new pieces and others required in the expedition to Mount Wilson, including a special spectrometer, plate carrier, and other apparatus, was done by the instrument maker, Mr. A. Kramer.

A great many of the "solar constant" observations made at Mount Harqua Hala, Ariz., were reduced by Mr. Fowle and Mrs. Bond in consultation with the director. Despite our long experience in solar-radiation work, new problems and difficulties still crop up. The publication of the Mount Harqua Hala results has hitherto been withheld so that a comprehensive discussion of them might be made to reveal and correct any systematic errors.

MONTEZUMA STATION

It became necessary for the director to undertake a visit to Chile to inspect the observing station at Montezuma maintained by the Hodgkins fund for the study of the solar variations, in cooperation with the stations in California and Arizona. Leaving Washington near the end of October, 1921, he spent the month, November 15 to December 15, at the station and returned to Washington early in January, 1922. During the month at Montezuma he revised all the adjustments of apparatus and some of the methods employed there, besides assisting in the daily observations and reductions on 26 days. Silver-disk pyrheliometer S. I. No. 5, loaned by the Department of Agriculture for the purpose, was compared with instruments at Montezuma, and before and afterwards with instruments at Washington. No change in the scale of pyrheliometry was disclosed by these comparisons.

EXPEDITION TO MOUNT WILSON

In June an expedition, including the director and Mr. L. B. Aldrich, went out to Mount Wilson. Four objects were in view. First, to inspect the station at Mount Harqua Hala and compare pyrheliometers there with silver-disk pyrheliometer S. I. No. 5, above mentioned, so as to connect the fundamental scales of pyrheliometry in Arizona and Chile. Second, to repeat with all possible precautions and variations of method the determination of the form of the solar spectrum energy curve outside the atmosphere. Third, to undertake preliminary measurements of the distribution of energy in the spectra of the brighter stars. Fourth, to try further experiments with the collection and storage of solar heat for cooking purposes.

The station on Mount Harqua Hala was visited by the director and found in a highly improved condition owing to the zeal of Mr. Moore, in charge there. The laboratory has been sheathed outside with metal to protect the adobe walls from rain and painted and embellished within, lightning rods have been installed, a small shop built, wireless telephonic apparatus erected, a garage built at the foot of the mountain trail, and regular weekly mail and supply trips arranged. Solar-constant observations have been made on upward of 70 per cent of the days of the year, and much computing and testing attended to. Comparisons made during and after the director's visit show no change in the scale of pyrheliometry, so that as far as this is concerned the results at Harqua Hala are comparable with those at Montezuma, but from lack of sensitiveness of the galvanometer the energy curves show less detail at Harqua Hala, and this it was decided must be corrected as early as possible to put the two stations on parallel footings.

Improved short method.—In conversation with Mr. Moore, the director devised a new improvement of the "short method" which, it was agreed, would promote accuracy while greatly abridging computation. This will be introduced at both stations as soon as the new determination of the form of the solar energy curve outside the atmosphere is worked out.

Energy spectrum of sun.—At Mount Wilson, the time before the end of the fiscal year, June 30, only sufficed for a partial installation of new "solar-constant" apparatus replacing that which in 1920 was removed to Harqua Hala; but it may be said by anticipation that results were later secured on the distribution of energy in the spectra of 11 of the brighter stars by bolometric work in connection with the 100-inch telescope, and also that the solar-energy curve was traced bolometrically with both glass and rock-salt prisms. With the latter, experiments were made at wave lengths from far down in the ultra-violet to an infra-red wave length of 14 microns, with allowance for stray light and for atmospheric and instrumental transmission.

Unfortunately the cover of the oil reservoir of the solar cooking apparatus had been blown off in a very high wind, and snow having gotten in, much water had leaked into the oil reservoir. After a long time of fruitlessly attempting to boil out this water, the oil and water were at length removed, but not in time to undertake the proposed new experiments before the return of the expedition to Washington in September.

OPINIONS OF THE SOLAR RADIATION WORK

As the Institution is making great efforts to continue and to improve its solar-radiation measurements, the director felt concerned to invite the opinions of competent critics, in order to know if these labors seemed quite justified by their probable outcome. Accordingly, in a report to the American representatives of the International Astronomical Union he wrote as follows:

> It is the intention of the Smithsonian Institution to continue daily observations at Mount Harqua Hala and Montezuma certainly until July, 1923, at which time it is proposed to consider the state of the work and the results reached with a view to deciding whether it is worth while to continue daily observations of the variability of the sun indefinitely or whether the usefulness of that work is unequal to the trouble and expense involved.
>
> An expression of opinion on the part of those interested in the subject would be of great value to the Smithsonian Institution in making this decision.

In their meeting at Washington, April 3 and 4, 1922, the asembled American representatives, including meteorologists, physicists, and astronomers, passed unanimously, after earnest supporting speeches, the following resolution:

> *Solar radiation.*—Moved: That it is the sense of the American section of the International Astronomical Union that the continuation of the solar-radiation work under the auspices of the Smithsonian Institution in at least two stations is highly desirable, both from an astronomical and a meteorological point of view. Adopted.

Later, in the Congress at Rome, May 2, 1922, the international representatives indorsed this opinion with equal unanimity and earnestness, passing the following resolution:

> The section of meteorology of the International Geodetic and Geophysical Union records its appreciation of the excellent work done by the Astrophysical Observatory of the Smithsonian Institution of Washington in determining with a high degree of accuracy the intensity of solar radiation outside the earth's atmosphere. It is of the opinion that the daily values now being obtained at Mount Montezuma, Chile, and Mount Harqua Hala, Ariz., will prove of great value in the solution of certain meteorological problems. It therefore expresses the hope that these determinations may be continued for a considerable period of years.

AUSTRALIAN AND ARGENTINE STATIONS

In view of these impartial expert opinions, it is a pleasure to add that Mr. John A. Roebling has made it possible to assure the continuation of the solar-constant stations at Harqua Hala and Montezuma until July, 1925. By that time sufficient data will doubtless be secured to prove whether they ought to be continued longer.

A movement is being made in Australia, led by Rev. E. F. Pigot, of Riverview College, to provide a solar-constant observing station similar to those maintained by the Smithsonian Institution. Funds have been raised there, and a portion of the apparatus has been purchased from the Institution. Also the Meteorological Service of Argentina is proposing to equip its station at La Quiaca for similar observations, in order the more directly to support the regular weekly long-range forecasts which it bases on solar radiation results. In order to aid these enterprises, the director has designed a full set of solar-constant apparatus, and it is expected that within the next fiscal year two sets will be prepared by contract for the Australian and Argentine stations.

PERSONNEL

Mr. A. F. Moore, field director at Mount Harqua Hala, was added to the staff of the Astrophysical Observatory on July 1, 1921.

SUMMARY

The outstanding event of the fiscal year was the publication in June, 1922, of Volume IV of the Annals of the Astrophysical Observatory, covering results from 1912 to 1920. New apparatus and methods are described, a critical survey of the work is given, and long tabular summaries of all solar observations made are included. From these results it is indicated in numerous ways that the sun's output of radiation varies, that the march of its variations depends on the sun's rotation, and that it produces effects of several kinds on terrestrial physics and meteorology. Much progress has been made at the new station on Mount Harqua Hala. Solar-constant observations were made there on over 70 per cent of the days, but are withheld from publication until completely discussed for evidences as to systematic errors. Expeditions were made to Chile and to Mount Wilson.

FISCAL YEAR 1922–23

WORK AT WASHINGTON

Revision of short methods.—No observations were attempted at Washington. Mr. Fowle, Mrs. Bond, and the director, as much of his time as possible, were engaged in computations necessary (1) to the search for systematic errors in the work of Mount Harqua Hala, Ariz., and the application of carefully determined corrections thereto; (2) to the publication of a comparison of two years of observations at Mount Harqua Hala, Ariz., and Mount Montezuma, Chile (see Monthly Weather Review, February, 1923); (3) to the preparation of a new set of curves for use from January 1, 1923, in the short method of solar-constant determination at Montezuma, Chile; (4) to the search for systematic errors and the application of carefully determined corrections to Montezuma results on the new basis; (5) to the reduction of observations made at Mount Wilson in 1922 on the form of the solar spectrum energy curve and on the spectrum energy curves of ten of the brighter stars.

It was apparent from the comparison, just referred to, between the results of the two field stations that they were in close accord on the sun's variation. But the Chile station was employing in its reductions the results of work prior to 1913 on the distribution of radiation in the solar energy spectrum; while the Arizona station was employing results of 1920. Moreover, the pyranometer in use in Chile was of an old type unsuitable to the work. Furthermore, the sharpness of definition of the spectrum employed at Mount Harqua Hala was inferior to that employed at Montezuma. It seemed probable that to remedy these defects and put the two stations on equality in all respects would lead to even closer harmony in their results, although it meant a revision of the whole scheme of reductions at both stations, with a redetermination of the systematic errors at each. This is very important, for the solar variations rarely exceed 5 per cent, and are mainly less than 2 per cent. It taxes the best observing to reveal them. These were the circumstances which led to the large computing program stated in the preceding paragraph. It has resulted in putting the two stations on equal footing in every possible way. They are now capable of turning out jointly the best results on the solar variation that our experience can suggest a means to attain.

Australian and Argentine outfits.—The instrument maker, Mr. Kramer, has been on detached service for almost the entire year, engaged in the preparation, according to plans of the director, of two solar-radiation outfits ordered, respectively, by a committee of interested gentlemen in Australia and by the Government of Argentina. The Australian outfit was finished and sent forward in June, 1923. The Argentine outfit will go forward about December, 1923.

FIELD WORK AT MOUNT WILSON

Energy spectrum of sun.—Messrs. Abbot and Aldrich observed on Mount Wilson in the months of July, August, and the fore part of September, 1922. They redetermined the form of the solar-spectrum energy curve. For this investigation they employed several different prisms, including two of rock salt. Their object in this course was to vary the procedure, so far as possible, so as to get several independent checks on the results. Upon reduction, all of the results of 1922 came into good accord with one another, and confirmed the work of 1920 very satisfactorily. It now appears that a large part of the earlier work, on which results published in Volumes III and IV of the Annals were based, was injured in accuracy by the employment of a quartz prism of inferior transparency. If this quartz prism work is rejected, the remaining early work is in fair accord with that of 1920 and 1922. The new results, therefore, now are accepted, and were published immediately after their completion. (Smithsonian Miscellaneous Collections, vol. 74, no. 7, 1923.)

In the course of this solar energy spectrum work, the observers made solar-energy curves with rock-salt prisms at different hours of the day, extending as far down the spectrum as to wave length 14 microns. As yet these observations are not reduced.

Energy spectra of stars.—A long and difficult task was undertaken in the observation of the prismatic energy spectra of 10 of the brighter stars in the focus of the 100-inch reflector on Mount Wilson. After much discouragement in preparation of apparatus and preliminary trials, successful results were obtained on three nights. The apparatus included a special bolometer and a special galvanometer. Changes of temperature of about one one-hundred-millionth of a degree centigrade were observable, and electric currents of about 10^{-12} amperes were read with the galvanometer of 10 ohms resistance. So sensitive was the device that it was affected to an almost incredible extent by electromagnetic induction. It even appeared that the operation of electric power in Pasadena and Los Angeles was effective to cause disturbance through the transmission lines up the mountain though cut off at the power house a thousand feet away from the telescope. Accordingly, best observations were made after 2 o'clock in the morning. The results are given in the paper just cited.

FIELD WORK IN ARIZONA AND CHILE

The Mount Harqua Hala station observed solar variation throughout the year under the efficient direction of Mr. A. F. Moore, assisted until April, 1923, by Mr. F. A. Greeley. Mr. P. E. Greeley, who had been at Montezuma, exchanged places with his brother and reported at Harqua Hala about June 8, 1923.

Mr. L. B. Aldrich assumed the directorship at Montezuma about December 20, 1922, succeeding Mr. L. H. Abbot. At both stations the results of 1923 have been very numerous. They had not yet been critically compared at the close of the period covered by this report.

RESULTS OF THE WORK ON SOLAR RADIATION

As long ago as 1903, we found in the observations then being conducted in Washington some indication of a variation of the sun's output of radiation. These indications were pursued for several years at Mount Wilson and Mount Whitney, and became so strong that, in 1911 and 1912, expeditions were maintained in Algeria, coincident with one at Mount Wilson, to test whether the supposed solar variations were really of local character. The results seemed confirmatory of real solar changes. The work went on in summer months at Mount Wilson, with gradual improvements up to 1920.

H. H. Clayton's researches.—In the meantime Mr. H. H. Clayton, forecaster of the meteorological service of Argentina, had communicated evidence, at first by letter and later in two Smithsonian publications (Effect of Short Period Variations of Solar Radiation on the Earth's Atmosphere, Smithsonian Miscellaneous Collections, vol. 68, no. 3, 1917; and Variation in Solar Radiation and the Weather, Smithsonian Miscellaneous Collections, vol. 71, no. 3, 1920) showing dependence of the weather of various parts of the world on fluctuations of solar radiation. These indications he has now amplified and recently elaborately published (H. H. Clayton, World Weather, Macmillan Co., New York, 1923). But even at the beginning, to one trained by the late Secretary S. P. Langley to hope that some time some connection would appear between solar and terrestrial changes, Mr. Clayton's work was very interesting.

At the writer's suggestion, Secretary Walcott approved the expenditure of accrued interest from the Hodgkins Fund to undertake all-year-round observations of solar variation in a cloudless climate. The Great War hindered the expedition, but it went forward in 1918 to Calama, Chile, a station chosen on the advice and extensive manuscript data furnished by Dr. Walter Knoche, formerly in charge of the weather service of Chile.

By that time Mr. Clayton's researches had led him to believe that actual forecasts might advantageously be based on solar-radiation work. Accordingly, soon after the establishment of the Chile station, arrangements were made to telegraph its results to Buenos Aires, and a system of forecasting based thereon has actually been in use in Argentina for several years. Some of its results are quoted in the book of Mr. Clayton, just cited.

The work almost immediately attracted the favorable attention of Mr. John A. Roebling. By his advice and financial assistance, the Mount Wilson work was transferred to a more cloudless locality for all-year-round observing at Mount Harqua Hala, Ariz., and also the Calama work was transferred to a higher station, Montezuma, outside the dust and smoke of Calama and Chuquicamata, which had been serious inconveniences.

During these many years, we had plodded on in hope of a satisfying fruition of our labors. Many signs there were that the solar radiation varies sufficiently to be of importance in terrestrial concerns. But they were of the nature of incompletely verified evidences of various sorts, all pointing the same way, but none in itself conclusive. With the continuous all-year-round occupation of the two first-rate stations, made possible by Mr. Roebling's generosity, the matter could be put, for the first time, to a rigorous test. And now we have made this test. It is conclusive and proves the substantial character of solar variation. Hereafter we walk by sight where hitherto we walked by faith.

In the publication cited (Monthly Weather Review, February, 1923) we show that in over 100 days, when results were obtained at both Arizona and Chile, the average deviation of one station from the other is 0.68 per cent, thus indicating a probable error of one day's observation at one station of 0.41 per cent. The average deviation for two years of monthly mean values between the two stations is 0.3 per cent, and this small value would doubtless be considerably smaller if the individual days of the several months had always been coincident. Although in opposite hemispheres, where winter at one station falls in summer at the other station, there is no evidence of seasonal divergence between the two stations. They unite in showing solar variation. Indeed the march of the monthly mean values from November, 1921, to September, 1922, in which they agree closely, gives the most conspicuous instance of long-continued solar change in a given direction which we have ever noted.

In short, there can not be, we think, any longer a reasonable question that the sun varies, or that our observations can reveal these variations satisfactorily. It is now a question for meteorologists whether these variations are of importance in weather forecasting. As we report these satisfying conclusions, it ought to be reported at the same time that the financial support furnished the Astrophysical Observatory by the Government would not have sufficed to obtain these results without the aid of the Hodgkins fund of the Smithsonian Institution, and the generous financial support and wise counsel of Mr. John A. Roebling.

Sun spots and solar radiation.—Although done a few days after the close of the period covered by this report, it will be fitting in this connection to mention some preliminary observations on changes of the appearance of the sun accompanying changes in the output of radiation. Being at Pasadena in July, 1923, the director availed himself of permission given by Director Adams to examine two years of record prints from direct photographs and hydrogen ($H\alpha$) spectroheliograms of the sun made at the Mount Wilson Observatory. Four general rules or principles seemed to be well established by the comparisons made.

1. When increased sun-spot activity appears, either by new spot groups forming on the visible solar disk, by the growth of spots already present, or by the coming on of a new group due to the solar rotation, then on that very day the solar-constant value increases.

2. When a sun-spot group is carried by the solar rotation across the central diameter of the visible disk, then the solar-constant value declines, and usually has a minimum on the day following such central transit.

3. When many spot groups, faculae, or long strings of dark hydrogen flocculi indicate that great solar activity is prevailing, the solar constant is high.

4. When a long quiescent period occurs in solar activity, the solar constant values steadily decline.

These rules connecting the solar radiation with the sun's visible appearance seem to hold some promise of quantitative development. Possibly there may be found some formula for computing solar-constant values by the aid of direct solar photographs and hydrogen and calcium spectroheliograms, which may enable the solar-radiation values to be expressed with fair approximation for the past quarter of a century. If so, it will be of great advantage.

PERSONNEL

In addition to the changes of personnel above mentioned, Mr. William H. Hoover was temporarily engaged as assistant beginning March 12, 1923. He is in training to be director of the proposed solar-radiation observatory of the Argentine Government at La Quiaca, Argentina. Mr. Hoover spent some time in Washington and some upon Mount Harqua Hala, Ariz. Mrs. Arline Leary served as temporary computer, beginning April 16, 1923. Both of these assistants were paid from funds given for the purpose by Mr. John A. Roebling.

SUMMARY

A comparison of two years of results on the variation of solar radiation observed at Mount Harqua Hala, Ariz., and Montezuma, Chile, shows close accord between the stations and agreement between them in showing forth solar changes of both long and short interval types. Monthly mean values of both stations indicate a long continued decline of the output of solar radiation beginning in November, 1921, and continuing at least until September, 1922. This is in some respects the most remarkable solar change on record. Great improvements have been made at both stations, and their observations have been put as far as possible on exactly equal footing. It is believed that beginning January 1, 1923, there will be still closer accord in their results. Definite correspondences have been observed between the variation of the sun's radiation and the variation of the most marked of its visible features. Several new determinations of the form of the sun's energy spectrum distribution curve confirm the similar work of 1920, and lead to a revision of the results of earlier work published in Volumes III and IV of the Observatory Annals. Energy spectra of 10 of the brighter stars were observed at the focus of the 100-inch telescope on Mount Wilson by means of a special spectrobolometric apparatus. Temperature differences of approximately one one-hundred-millionth of a degree centigrade were measured in this investigation. Solar-radiation outfits have been prepared for Australia and Argentina, to be installed in the year 1923.

FISCAL YEAR 1923–24

WORK AT WASHINGTON

Experimental weather forecasts.—As in previous years, the variation of the sun has been the main concern. The generosity of Mr. John A. Roebling enabled arrangements to be made for daily telegrams from our two solar-radiation stations. This service was begun September 13, 1923. The results obtained in Chile are cabled in code, so that the weighted mean solar-constant value, the date and hour of observation, and its grade are all included in two words. Messages arrive at Washington from both stations within 24 hours of the actual measurements, and generally represent mean results of five independent determinations at each station. Arrangements have been made (also owing to Mr. Roebling's interest and generosity) to test the value of the solar measurements for forecasting according to the methods of Mr. H. H. Clayton. For this purpose Mr. Clayton has had a small office [1] and one assistant near his home in Canton, Mass., where he receives before noon daily from the Smithsonian Institution the weighted mean of the solar-constant values observed in Arizona and Chile on the preceding day. He makes his forecasts for 3, 4, 5, and 27 days in advance, and mails them to the Institution on the same afternoon. Thus we receive the forecasts sufficiently long before their maturity to make a very real and searching test of their validity.

These forecasts for definite days relate to the mean temperature of New York City, and are later on compared with the observed temperatures and analyzed by several purely mathematical methods quite independently of any bias of the computer. The official weather services of the various countries do not, of course, make predictions parallel to these, except in Argentina, where such forecasts are made by similar methods to Clayton's. Hence it is impossible to know at present how much gain, if any, Mr. Clayton's solar forecasts show over the present official methods. That they do show some prevision of the event, even to five days after the solar observations, is certain.

Hitherto, however, the 27-day detailed forcasts have shown no correlation with the New York temperatures. This is not at all surprising. Indeed, all such

[1] Thanks are due to the Canton Historical Society for use of these quarters.

forecasts have to contend against great odds. For we recall that the march of temperature often goes quickly from crest to trough, so that even if a true forecast could be made, and it should be no more than 12 or 24 hours off in point of time, there would be large divergences between the prediction and the event. With the unyielding mathematical methods of verification this would greatly diminish the correlation found.

A fairer test for very long-range forecasts is found in general statements as to the expected departure from mean normal temperatures for coming months. These Mr. Clayton has furnished from 15 to 30 days before the beginning of each month from December, 1923, to the present time. He also furnishes similar predictions about the approaching weeks furnished three days before the beginning of the week in question. With few exceptions, these broader prognostications have been fairly verified.

On the whole, therefore, although the results are as yet far from being entirely satisfying, these experimental forecasts of Mr. Clayton's are promising enough to warrant further trial. New methods are continually being devised and tried in making them. Mr. Roebling has generously arranged to continue them until June 30, 1925. As the work is purely experimental no detailed publication of it will be made at present.

Naturally, if the forecasts made by Mr. Clayton really represent solar changes, he can not succeed unless good solar measurements are supplied. As soon as we began to receive daily telegrams from both stations occasional fairly wide disagreements of individual days commanded attention. We felt it necessary, in studying the causes of such disagreements, to revise again entirely the systems of little corrections to solar-constant values which have to be made to allow for the haziness and humidity of our atmosphere. This revision could be made with more advantage because many additional data had meanwhile accumulated.

Revision of solar constants.—Mr. Fowle and Mrs. Bond have worked over this matter during practically their entire time, which, however, owing to furlough, was only about three months in Mrs. Bond's case. A new method of determining these corrections has been devised by the director and Mr. Fowle, which eliminates satisfactorily the influence of the solar changes which have occurred. Hitherto this matter of solar change superposed upon the small terrestrial sources of error which we desire to eliminate has been very embarrassing. Of course, if one could wait many years before proceeding to evaluate the terrestrial effects, the solar changes, being independent or but loosely connected with local terrestrial ones, would be eliminated in the mean of a mass of observations. We can, indeed, after several years more of observing, finally proceed in this way. But wishing to make immediate use of our results a new method of procedure has fortunately occurred to us which permits us to avoid the interference of solar changes altogether. The details will be published soon.

As both to us and to the Chief of the Weather Bureau it seemed unwise to publish preliminary values of the solar constant which later on would have to be corrected, we have discontinued the frequent publications of them in the Monthly Weather Review which we have been accustomed to make for several years past. After we come to a fully satisfactory basis of systematic atmospheric corrections, these publications may be resumed.

Of the two solar-radiation stations, Montezuma, Chile, has proved far more suitable to the purpose than Harqua Hala, Ariz. It seems probable that a place somewhat farther west and decidedly higher would be preferable to Mount Harqua Hala. Violent storms occur there in various months of the year, and the summer months in particular have proved very unsatisfactory. If financial means were available it would be highly desirable to remove the station to another site, and, indeed, a better one is already selected which would present many advantages. The cost of removal would be about $7,000.

The systematic revision of results in the hands of Mr. Fowle and Mrs. Bond has led to much improvement, as shown by the close accord of daily solar-constant values at the two stations. For the period September, 1922, to March, 1924, the average daily difference is less than 0.5 per cent. In the month of October, 1923, when the weather was fine at both stations almost every day, it ran as low as 0.2 per cent.

The solar-constant values have continued almost without exception below normal. From March, 1922, until June, 1924, the mean result for every single month was below the normal value, which is 1.938 calories per square centimeter per minute. This long-continued defect of solar radiation may well have produced interesting climatic effects. It is interesting to report in this connection a letter from M. Antoniadi, of France, stating that the polar cap of Mars is larger than it has been under parallel conditions for 70 years, and asking if the solar-radiation measurements showed anything unusual. Naturally decreased solar radiation would tend to produce that effect.

A letter from the eminent meteorologist, Doctor Bjerknes, of Norway, to Doctor Hale, of the Mount Wilson Observatory, has been referred to us, and with permission of the author is here copied in part as an indication of expert appreciation of our work:

> I have been greatly interested in the establishment of a complete "circumpolar" weather service, as this only will give the full view of the changing states of the atmosphere. This circumpolar service is now beginning to become a reality. The charts may soon more or less cover the entire northern hemisphere.
>
> But then another idea arises by itself; namely, to bring these more and more complete pictures of the varying states of our atmosphere into connection with their ultimate cause—the solar activity. * * *

I am aware that the solar constant is determined every day at Mount Wilson Solar Observatory and at the Calama Observatory of the Smithsonian Institution. * * * I think it would now be of high importance to every day have the most recent value of the solar constant incorporated in the daily meteorological issue.

If this should be practicable, the value of the data which are every day at the disposal of the meteorologist would increase enormously. It is, of course, dangerous to prophesy. But a new era may perhaps begin for meteorology from the moment when the meteorologist has at his disposal every day complete data both for the sun's activity and for the state of the atmosphere over an entire hemisphere of the earth.

WORK AT THE SOLAR-RADIATION STATIONS

The results just discussed are, of course, the fruit of the zealous work of our observers in Arizona and Chile. Mount Harqua Hala continues under the direction of Mr. A. F. Moore, who was assisted until March 1, 1924, by Mr. P. E. Greeley. After Mr. Greeley's resignation, Mr. A. H. Worthing assisted from May 20 to June 30, but then resigned. At Montezuma, Chile, the station continued in charge of Mr. L. B. Aldrich, assisted by Mr. F. A. Greeley.

Many comforts and observing improvements have been added at both stations at small expense, owing to the ingenuity and hard manual labor of the observers. At both stations all possible days for solar-constant work have been utilized, and with very high accuracy of observation. About 75 per cent of all days were observed in Arizona and above 80 per cent in Chile. The months of July, August, and September, however, were very unfavorable at Harqua Hala, because of unusual cloudiness which prevailed all over that section of the United States. This abnormal state of the sky was indeed made specially prominent by the almost complete failure of all the California observations of the total solar eclipse of September 10, 1923. Many observations of these months must be rejected on account of unfavorable sky.

Mr. W. H. Hoover assisted Mr. Moore for a few weeks in May, 1923. While Mr. and Mrs. Moore were away in Australia setting up near Sydney a solar-radiation outfit ordered by Rev. E. F. Pigot, of Riverview College, for a committee of interested Australians, Mr. and Mrs. Hoover relieved them at Harqua Hala from July until September. Mr. Hoover was thus prepared by actual field experience to be director of the Argentine Government's new solar-radiation station at La Quiaca.

Establishment of Argentine station.—The outfit for this station was prepared at the Smithsonian Institution after designs of the writer, and the finer parts, such as those of the bolometer and galvanometer, were constructed by Mr. Hoover. Shipment was made in January, 1924, and the station at La Quiaca made ready for solar observing in June, 1924. Thus the Argentine Government is the first agency outside the Smithsonian Institution to undertake regular determinations of the variation of the sun. Their official weather service still receives daily telegraphic reports from our station at Montezuma, Chile, and it will supplement these by its own solar-radiation measurements at La Quiaca.

FIELD WORK AT MOUNT WILSON

The director and Mrs. Abbot occupied this station from July to October, 1923. Three objects were in view:

Atmospheric ozone.—First, to set up apparatus and begin observations on the variations of atmospheric ozone after the ingenious spectroscopic method of Fabry and Buisson. M. Fabry was so kind as to supervise the ordering in Paris of all the special quartz and fluorite optical parts needed. Owing to the detached service of the Smithsonian instrument maker, Mr. Kramer, who was engaged in making the Australian and Argentine solar-radiation outfits, no work had been done toward mounting the optical parts for ozone studies, or, indeed, toward preparing for other experiments of the expedition. So it happened that the director spent several weeks on Mount Wilson at instrument making and was not quite ready to begin the ozone observations in 1923.

Solar cooker.—The second object was to test new improvements on the solar cooker. By the lively interest of Director Stratton, the Bureau of Standards had constructed by their skillful glass blower, Mr. Sperling, a long, pyrex-glass, double-walled vacuum tube to inclose the heater tube of the Mount Wilson solar cooker. As stated in Volume IV of the Annals of the Astrophysical Observatory, nearly nine-tenths of the loss of heat had hitherto occurred from the heater tube within the great mirror. It was to check this loss that the new device was planned.

Unfortunately, the aluminum of the mirror was found much deteriorated and could not be fully restored by polishing. Hence the mirror was very inefficient in 1923. Nevertheless, the vacuum tube showed its efficiency by the fact of the heating of the oven to 175° C., or fully 25° C. above the usual maximum temperatures of 1920. But new troubles arose. The oil circulation became leaky at the new high temperature, spontaneous combustion of the cotton heat insulation occurred, and the experiments had to be stopped after long-continued vain attempts to close the leaks by soldering. Also the vacuum tube, which was really made too long for safety, soon broke under the unequal heating strains. After this breakage occurred the maximum temperatures attained were but 120° C., showing that over 50° C. of advantage came from the employment of the vacuum device. The experiments seemed so promising that a continuation of them was arranged for 1924, and new and improved instrumental constructions were prepared by Mr. Kramer during the winter months.

Radiometer measurements on stellar spectra.—The third piece of work attempted was with the 100-inch telescope on the energy spectrum of the brighter stars. Messrs. Abbot and Aldrich had, indeed, done this with moderate success in 1922, employing the vacuum bolometer and galvanometer. But great trouble had been found in the use of those instruments at extreme sensibility. Fortunately, the late Dr. E. F.

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Nichols had offered to have prepared a radiometer of improved design for the work. This instrument, constructed by Dr. J. D. Tear, proved equally as sensitive as the bolometer used in 1922, and practically as easy to use as a meter stick.

With it and with a new optical arrangement designed by the writer, and largely constructed by him, very interesting results were obtained. The spectra of 10 stars, including the sun, as cast by a 60° flint-glass prism, were measured successfully. As the sun's energy spectrum is well known, it was possible to eliminate by comparison with it all of the chief instrumental and atmospheric losses. Thus the results appear as stellar energy curves outside our atmosphere, expressed on the normal or wave-length scale. As the deflections observed were fairly large, no less than 50 millimeters at maximum in the spectrum of Betelgeuse, for example, the curves are of very fair accuracy over most of their extent. It was possible to improve them in the shorter wave-length region where they were inaccurate by employing visual and photographic results of German observers. Thus the whole of the intense part of the spectrum of the yellow and red stars and a large part of that of the white and blue ones were well delineated. From these results good estimates could be made of the star temperatures on the "black-body" basis. Furthermore, estimates of the diameters necessary in "black bodies" to produce at those temperatures the observed amounts of energy were made. It is gratifying to find these results on stellar diameters as accordant as could be expected with those of Pease made by means of Michelson's method of the interferometer. A summary follows:

Stellar temperatures, radiation, and diameters

Star	Absolute temperature C.	N,[1] Unit= 10^{-11}	Paralax	Diameter ⊙=1 [2]		
				Radiometer	Interferometer	Russell
	Degrees		"			
Sun	6, 000					
β Orionis	16, 000	3. 20	0. 007	20		2. 8
α Lyrae	14, 000	6. 10	. 130	2		3
α Canis Majoris	11, 000	6. 60	. 370	1. 2	2	
α Canis Minoris	8, 000	1. 24	. 315	1. 1		1. 6
α Aurigae	5, 800	2. 20	. 071	13		9
α Tauri	3, 000	2. 54	. 053	70	39	
β Pegasi	2, 850	1. 11	. 026	94	82	
α Orionis	2, 600	7. 90	. 017	510	280	
α Herculis	2, 500	3. 60	{ . 007 { . 013	900 480		230

[1] N=ratio of stellar to solar radiation outside earth's atmosphere.
[2] To express in kilometers, multiply by 1.42×10^{6}. To express in miles, multiply by 0.865×10^{6}.

SUMMARY

The year has been notable for the establishment of daily telegraphic solar-constant intelligence from Montezuma, Chile, and Harqua Hala, Ariz., through the interest and generosity of Mr. John A. Roebling. Also, due to the same support, experimental temperature forecasts for New York City, based on these daily reports of solar changes, have been regularly submitted by Mr. H. H. Clayton for certain periods of time in advance. Revision of the solar-radiation results of the two stations shows average daily accord to less than 0.5 per cent in their solar-constant determinations. Observations have been received from one or both solar-radiation stations on about 90 per cent of all days. Further experiments with the solar cooker have resulted in some advancement and have pointed the way to further progress. Apparatus has been made ready for determinations of atmospheric ozone after the method of Fabry and Buisson. Highly interesting results on stellar energy spectrum distribution and on star diameters have been obtained with a Nichols radiometer in cooperation with the Mount Wilson Observatory of the Carnegie Institution.

FISCAL YEAR 1924–25

WORK AT WASHINGTON

Experimental weather forecasts.—The chief object of the work at present is to secure the most exact measurements of the variation of the sun in order to provide proper data for studying the influence of solar changes on weather conditions of the United States and the whole world. Accordingly, the efforts of the staff were devoted mainly to this purpose. The Government appropriations were sufficient only to maintain the work at Washington and Arizona, and to pay salaries of two observers at the exceptionally favorable station at Montezuma, Chile. This station was established in 1918, and has been maintained ever since by private funds of the Institution, supplemented by gifts of Mr. Roebling. Owing to further support by Mr. Roebling, it has been possible to receive daily telegrams reporting the solar-radiation observations in Chile and in Arizona. These arrive at Washington within 24 hours of the observations in the field.

The experimental forecasts by Mr. H. H. Clayton for the city of New York, mentioned in last year's report, were continued. For this purpose daily telegrams of the condition of the sun were sent from Washington to Mr. Clayton at Canton, Mass. These usually reached him before noon on the day after the observations were made in Chile and Arizona. Making up his New York forecasts for 3, 4, and 5 days ahead, Mr. Clayton informed the Smithsonian by letter on the same afternoon. On Friday of each week he forecasts the temperature departures for the ensuing week beginning Sunday, and about the end of each month he forecasts the temperature departures for the ensuing month. These weekly and monthly forecasts were also mailed in advance to the Smithsonian Institution.

We have compared Clayton's forecasts with the events, using mathematical processes of verification which are not susceptible of personal bias. A moderate degree of foreknowledge is certainly indicated, both for the specific forecasts of

3, 4, and 5 days in advance, and for the more general average forecasts of weeks and months.

On May 2, 1925, a symposium on this subject was held at the United States Weather Bureau before the American Meteorological Society. At that time, Messrs. C. G. Abbot and H. H. Clayton explained the status of the measurements of solar variation, and their applications for forecasting. Later, these papers of Abbot and Clayton, and also a paper by Mr. G. Hoxmark, on the results reached since 1922 in the application of solar variation for official forecasts in Argentina, were published as Nos. 2825, 2826, and 2827 of the Smithsonian Miscellaneous Collections.

The costs of telegraphic advices and of Mr. Clayton's computing bureau have been borne by Mr. Roebling's gifts for these purposes, as also the cost of publication of the papers just mentioned.

No public forecasts have been made or will be made under the auspices of the Smithsonian Institution. Our entire purpose in the matter is, and has always been to make such experiments as might indicate what value, if any, would attach to the introduction of a new variable, namely, the variation of the sun, in weather forecasting. Our forecasts are made privately and only as tests of the experimental conclusions.

Unfortunately, space writers in the public prints have not understood this and have attributed to the Smithsonian Institution forecasts of weather conditions far into the future. These, in reality, have been made by several private individuals entirely unconnected with the institution. We take no responsibility for these prognostications, as we know as yet of no sound method by which they may be made.

A compilation of all results on the solar constant of radiation, from 1918 to November, 1924, was published as No. 2518 of Smithsonian Miscellaneous Collections.

Improved pyrheliometry.—The investigations hitherto made having indicated that a higher degree of accuracy in our solar measurements is needed to supply proper data for forecasting purposes, a very great deal of attention has been given to the elimination of small sources of error in the observations and reductions of solar radiation. Already the average deviation of individual days' results between Chile and Arizona is but one-half per cent. It follows that in order to attain higher accuracy we shall be obliged to regard sources of error which formerly we supposed would always be negligible.

This has led to the designing and construction of new apparatus for use in pyrheliometry, which eliminates the employment of the observer's watch altogether. It has also required the investigation of the infra-red and ultra-violet portions of the solar spectrum, beyond the usual limits of our daily spectrum observations.

Still more important, it has led to a complete revision of the methods of measuring and reducing solar energy spectra. With these new modifications in mind, a complete re-reduction of all solar-radiation work since the beginning of the year 1922 has been undertaken, and occupies the whole force at Washington.

WORK IN THE FIELD

Removal from Harqua Hala, Ariz., to Table Mountain, Calif.—The station at Mount Harqua Hala, Ariz., first occupied in 1920, proves to be too far to the east, so that the summer months there are unsuitable for observing, because of the atmospheric conditions which go to bring about the severe thunderstorms of Arizona. Very few days of June, July, and August have been suitable for our exacting work, and even some of the spring months have been marred by long-continued haziness. Had weather conditions there been first-rate, the observers would gladly have suffered the excessive isolation of the place, which is almost wholly cut off from relaxations, but to make such a sacrifice fruitlessly is indeed very depressing.

Accordingly, investigations have been made which have fixed on a better site, both as regards weather conditions and comfort. This is chosen on Table Mountain, within the bounds of the Los Angeles County Park, about 30 miles northeast of Mount Wilson. Lying on the edge of the Mojave Desert, at 7,500 feet elevation, the weather observations indicate very decided improvement over Harqua Hala for our purpose. Add to this the convenience of access and pleasant surroundings and we have combined there great advantages.

Mr. John A. Roebling has added to his already great gifts sufficient means to enable necessary buildings to be erected on Table Mountain and to remove the observing outfit thence from Harqua Hala. The supervisors of the Los Angeles County Park have cordially assisted in the transfer, giving rights of occupancy, and extending the auto road quite to the doors of the proposed observatory, without expense to the Smithsonian Institution. It is expected to occupy Table Mountain beginning about October 1, 1925. Mr. Moore's energetic efforts in the preliminary arrangements and the preparation of buildings deserve high praise.

Solar cooker.—An expedition under Doctor Abbot occupied Mount Wilson in the summer and autumn of 1924. The solar cooker was rebuilt, as far as concerned its oven, its circulatory system for hot oil, and its insulation against heat losses. The new oil system was perfectly successful in avoiding all leaks, such as always hitherto have marred the operations. Also the introduction of a larger reservoir, and especially of "Silocel," or diatomaceous bricks, for heat insulation proved highly satisfactory. The experiment was tried of introducing forced oil circulation by means of a little steam engine operated by the heat of the reservoir. This worked well mechanically, but proved unnecessary, as no higher temperatures of the ovens were reached when forced circulation was in operation.

It was intended to use a vacuum jacket about the heater tube, but the apparatus was not received in season. Without this crowning improvement the solar cooker worked fully as well as in 1920, when its reputation was first made, despite the fact that somewhat thicker insulation of the reservoir is needed, as the cooling curve shows. When this, and also the vacuum jacket, are applied, the machine should be highly satisfactory.

Spectral distribution of solar variation.—As noted in last year's report, the Fabry type of apparatus has been installed on Mount Wilson to measure the quantity of atmospheric ozone. This feeble constituent of the very high air is, we believe, very important in the economy of the earth's heat, as well as a fatal bar to observation of the most interesting part of the spectra of the sun and the hotter stars.

Having fully developed and tested the ozone outfit, photographic solar spectra of the ozone-absorption region of the ultra-violet were obtained in August, September, and October, 1925. Unfortunately the great forest fire east of Mount Wilson cut off a good many otherwise favorable days. By the generosity of Mr. Roebling a copy of the Moll spectrophotometer for measuring the plates has been procured from A. Hilger. The reductions are not yet made. Mr. Roebling's interest in this ozone research is so great that he has made a grant to enable Doctor Fabry himself to continue daily ozone measurements in France during a part of the year 1925.

The importance of studies of the variation of the sun's output of ultra-violet rays grows upon our attention. Not only the attack on the ozone problem in that spectral region, but also the extraordinary relations of the ultra-violet rays to human, animal, and plant physiology are coming increasingly to the fore. Our own studies indicate that the solar variations are far greater for those rays than they are for the solar rays as a whole. Thus the accompanying figure indicates that when the solar constant of radiation changes by 1 per cent it means almost imperceptible change for the infra-red rays, but as much as 10 per cent or more for some rays of the ultra-violet.

In addition to the work at Mount Wilson on the solar cooker and the ozone of the higher atmosphere, much attention was paid to attempts to improve the radiometer and the stellar-spectrum apparatus, in the hope of going much further in studying the energy spectra of the stars. Much knowledge was gained which will be useful later on, and star-spectrum observations were made on several nights, but no actually completed advance in stellar spectra was attained. The way, however, is very clear now for future advance.

PERSONNEL

Mr. H. B. Freeman accepted service on the private Smithsonian roll as assistant at Harqua Hala in September, 1924, and succeeded Mr. L. B. Aldrich in charge at Montezuma on March 1, 1925. Mr. Aldrich returned to Washington.

Mr. E. E. Smith was employed on the private roll as assistant at Harqua Hala from February 9, 1925.

Mr. A. J. Ahearn assisted Doctor Abbot on Mount Wilson during the expedition of 1924.

SUMMARY

Much progress in the study of the variation of the sun and its application to weather forecasting has been made, as reported in publications Nos. 2818, 2825, 2826, and 2827 of the Smithsonian Miscellaneous Collections. Improvements in apparatus and methods designed to add to the accuracy of solar-radiation measurements, and to make possible a valuable revision of existing values, are on foot. The station at Harqua Hala, having proved somewhat disappointing, is being removed to Table Mountain, in California, about 2,000 feet higher, but much more accessible. The solar cooker has been greatly improved. Measurements of atmospheric ozone are in progress. New devices were tried in stellar energy-spectrum measurements and the way seems clear for great advances in that line.

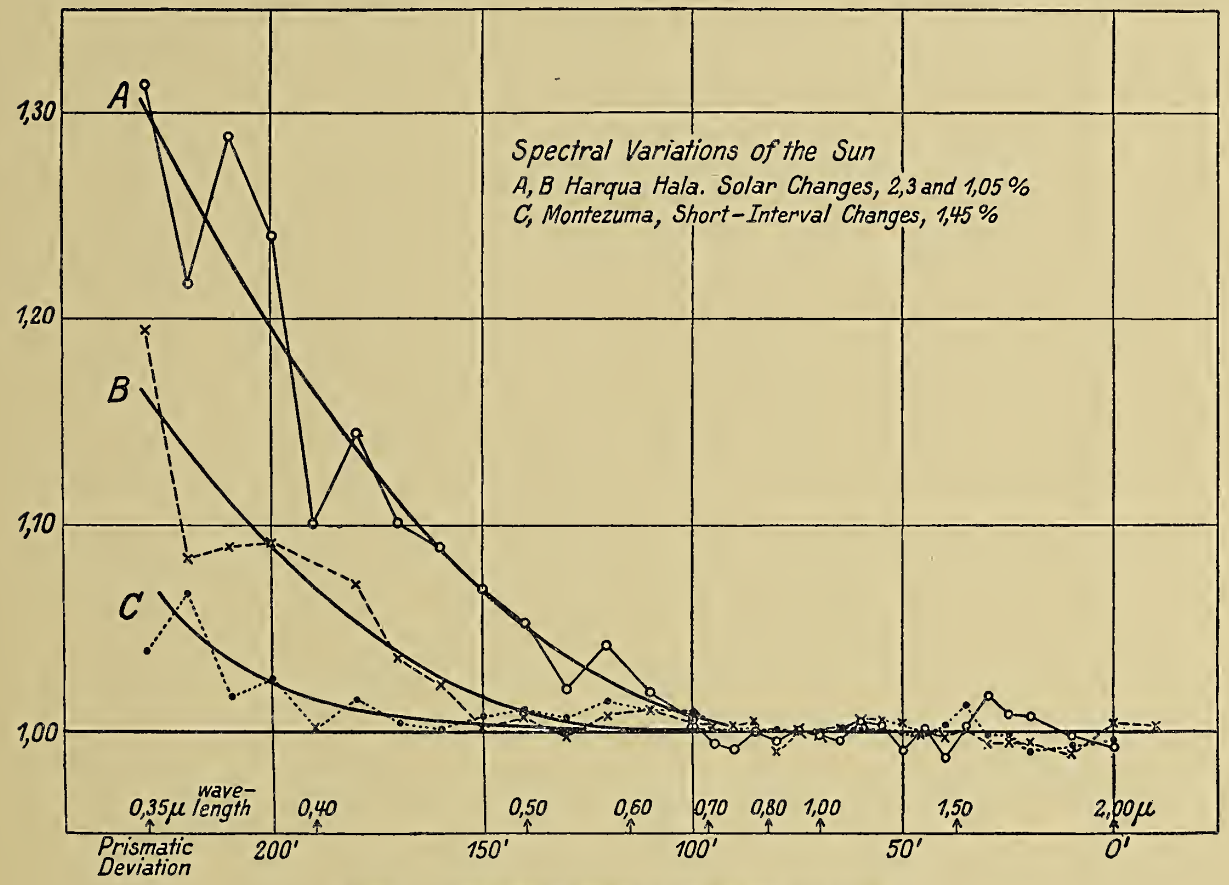

FIGURE 1.—Solar variation localized in the violet and ultra-violet

FISCAL YEAR 1925–26

During the year the Astrophysical Observatory has assumed part of the cost of the maintenance of the observing station at Montezuma, Chile, which was erected in 1920, with means furnished by Mr. Roebling. The constructions there comprise a tunnel for instruments, a dwelling, shop, and garage, and a telephone line 12 miles to Calama.

NATIONAL GEOGRAPHIC SOCIETY STATION

The National Geographic Society, having become interested in our efforts to obtain an accurate series of measurements of the variation of solar radiation, made a grant in March, 1925, of $55,000 to be expended by Dr. C. G. Abbot for the following purposes:

1. To select the best location in the Eastern Hemisphere for a solar-radiation station to cooperate with the two now operated by the Astrophysical Observatory for the measurement of solar variation.

2. To equip the station selected.

3. To send an expedition to be known as the National Geographic Society Solar-Radiation Expedition Cooperating with the Smithsonian Institution to continue solar-radiation observations as long as the grant permits, estimated at four years.

In furtherance of this project, Mr. W. H. Hoover, hitherto director of the Argentine solar-radiation observatory at La Quiaca, and Mr. F. A. Greeley, hitherto assistant at Harqua Hala and at Montezuma, were engaged as director and assistant for the new station. Apparatus was ordered, and Mr. Andrew Kramer, instrument maker to the Astrophysical Observatory, was transferred to construction work under the National Geographic Society's grant. Mr. Aldrich undertook the finer work of constructing galvanometer, pyrheliometer, bolometer, and pyranometer parts, and of standardizing them as well as oversight over the preparations.

Doctor Abbot went abroad to Algeria, Egypt, Baluchistan, and Southwest Africa to select the location. Preference was given to the Brukkaros Mountain in Southwest Africa (long. 17° 48′ E., lat. 25° 52′ S.). This is an isolated cup-shaped peak 5,002 feet in elevation, rising precipitously from a level plateau of 3,000 feet elevation. The average yearly rainfall in the vicinity is 3½ inches. A Hottentot reservation surrounds the mountain, and the nearest town is Berseba, 7 miles south, where there are only two white inhabitants, the others Hottentot. Supplies would come from Keetmanshoop, 60 miles distant by auto. Water in small but sufficient quantity is found on Mount Brukkaros.

The construction is undertaken by the public-works department of Southwest Africa under Mr. A. Dryden, inspector. It is proposed to have a tunnel for instruments, a small dwelling for observers, a shop, a reservoir, and garage. Wire telephones will be installed by the Government of Southwest Africa and rented to the expedition. Work was begun in April and it was hoped to send the expedition in early autumn.

Though so isolated, the location is in other respects very promising. The average rainfall of only 3½ inches occurs as a rule one-third in February, one-third in March, and the rest scattering. Doctor Abbot was in the vicinity 12 days in March, of which 11 would have been favorable for observing. If this is characteristic of the rainy season, it promises well for the year as a whole. It is also favorable that the greatest cloudiness comes in the months of February and March, rather than December and January, as is the case in the two American stations. Good months may be expected in Africa when the poorest observing weather occurs in America. The clearness of the sky in that part of Southwest Africa is extraordinary, and the wind velocity is usually very low.

TABLE MOUNTAIN STATION

Actual experience over five years at Mount Harqua Hala, Ariz., has proved less satisfactory than was expected. Although the number of days when it was possible to observe averaged above 70 per cent, there were many months when most of the days were extremely hazy. Especially is this apt to occur in June, July, August, and early September, months when in former years we were accustomed to obtain excellent conditions at Mount Wilson. These unfortunate conditions required the discarding of many observations made at Harqua Hala. Though recently means have been found, as will be explained below, to minimize this disadvantage, yet it was very unfavorable to the morale of the observers to be required to stay in so extremely isolated a spot, and yet to know that the results in some parts of the year were not as good as might have been obtained in very much more agreeable living conditions.

After consulting all available records, and after having special observations made during the autumn, winter, and spring months, it was decided that Table Mountain in California (long. 117° 41′ W., lat. 34° 23′ N., alt. 7,500 feet) would be preferable at all times of the year from the point of view of the sky conditions. Its excellent status for summer was well known already, because it lies only 30 miles away and almost in sight from Mount Wilson, where the summer observations of Messrs. Abbot and Aldrich for many years were reliable guides. As for comfort of the observers, Table Mountain is remarkable, for it lies near a good auto road, only four hours from Los Angeles, and is in a grove of great pine trees, forming part of the Los Angeles County Park. A store and amusement hall are within a mile, and many cottages are still nearer.

Mr. John A. Roebling added to his generous gifts a sufficient sum to defray costs of construction of road, tunnel-shaped observatory, a cottage for director, a second cottage for assistant, a shop, garage, and other accessories. The members of the board of supervisors of Los Angeles County were exceedingly helpful and cordial, especially in their approval of the sole occupancy of a site within the park for the observatory, in constructing an auto road and water service to connect with existing roads and reservoirs at Camp McClellan, and in cooperating with the Smithsonian Institution in erecting a telephone line to connect with the outside world.

Mr. A. F. Moore, field director at Harqua Hala and Table Mountain, designed and superintended all the construction, the removal from Harqua Hala, and the installation at the new site. He, himself, did no small share of the actual labor involved. Since October, 1925, the observations have been going on regularly at Table Mountain. The high quality of the sky conditions has been found to amply justify the removal, and despite an unusually stormy spring in that part of the United States, the number of observing days thus far has kept on a par with the average of five years at Harqua Hala.

From the beginning of the work at the new station, the methods of observing and reduction have been put in the most complete accord with latest experience and with those employed at Montezuma. Furthermore, as it had been found that on very hazy days the brightness of the sky around the sun contributed an amount not negligible to the reading of the pyrheliometers, there were substituted on those instruments new vestibules of four times the former length. In this way the cone of sky, as seen from the sensitive part of the instrument, is cut down from a diameter of 10° to a diameter of 3⅓°. Had this improvement been devised and made in 1920 a good many now worthless observations made at Harqua Hala might have been saved.

APPRECIATIONS BY NATIONAL ACADEMY AND OTHERS

When, in the year 1924, Mr. Roebling informed the Institution that he felt that his part in developing the solar-radiation work should be ended with June 30, 1925, it was necessary to procure other support, or abandon the Chilean observatory. Accordingly, letters were prepared asking the National Academy of Sciences, the Chief of the United States Weather Bureau, and the director of the meteorological office of the Air Ministry of Great Britain whether in their judgment the public value of the observations warranted asking for sufficient increase of the governmental appropriation for the Astrophysical Observatory to carry on the Montezuma station.

President Michelson of the National Academy of Sciences appointed a committee consisting of Dr. W. W. Campbell, chairman, Dr. R. A. Millikan, and Dr. G. N. Lewis, to consider the matter. Their report, which was unanimously adopted by the Academy, follows:

National Academy of Sciences,
Washington, D. C., April 30, 1924.

Prof. A. A. Michelson,
President National Academy of Sciences,
Washington, D. C.

Dear Sir: Your committee, charged with the duty of considering the proposed program of the Smithsonian Institution for measuring the heat radiations of the sun, begs to present the following report:

Dr. C. G. Abbot, Director of the Astrophysical Observatory of the Smithsonian Institution, several years ago made the notable discovery that the intensity of the heat received by the earth from the sun varies in remarkable extent and manner. Through the last two years, beginning with February, 1922, the sun's heat radiations to the earth have been continuously subnormal. The consequences of this deficiency in heat received can not be predicted at this time, but the general subject is undoubtedly one of great importance. We regard it as a national duty and a national opportunity that the observations be continued for a long time to come, and certainly through two complete sunspot cycles of 11 years each.

The principal stations for securing these observations have been located at points noted for their pure skies and their very great number of clear days in the year: At Mount Harqua Hala in Arizona, in the Northern Hemisphere, and at Montezuma in Chile, in the Southern Hemisphere.

The observing station in Chile has been operating successfully since August, 1918, but funds are not in sight to continue its activities beyond July, 1925.

For the reasons briefly stated above, this committee recommends that the National Academy of Sciences advise and request the National Government, through the Director of the Bureau of the Budget and the Appropriation Committees of Congress, to make financial provision for maintaining the Smithsonian Institution's Observatory in Chile without interruption of service.

Respectfully submitted,

Gilbert N. Lewis,
R. A. Millikan,
W. W. Campbell, *Chairman.*

In transmitting it to the Secretary of the Smithsonian Institution, President Michelson himself wrote:

National Academy of Sciences,
June 5, 1924.

My Dear Mr. Secretary: Your communication of April 12, 1924, and that of the assistant secretary of the Institution in regard to funds for the maintenance after July, 1925, of the Chilean observatory under the direction of the Smithsonian Institution were referred to a special committee of the National Academy of Sciences, and I am inclosing, for your information and such use as you may desire to make of it, a copy of the report presented by that committee and approved by the academy.

It will be noted that this report recommends that the National Academy of Sciences "advise and request the National Government, through the Director of the Bureau of the Budget and the Appropriation Committees of Congress, to make financial provision for maintaining the Smithsonian Institution's observatory in Chile without interruption of service." Assuming that the Smithsonian Institution will communicate direct with the Bureau of the Budget, the academy will take no further action unless you find that it can serve you further in the matter.

The value of knowing the variations in heat available from solar radiation to the earth can not be overestimated. I am glad that the academy has been given this opportunity to aid in your efforts to secure funds from Congress for the purpose, and hope that your efforts in this direction will be successful.

Very respectfully yours,

A. A. Michelson, *President.*

Hon. Charles D. Walcott,
Secretary, Smithsonian Institution,
Washington, D. C.

Professor Marvin, Chief of the United States Weather Bureau, replied:

United States Department of Agriculture,
Office of the Chief, Weather Bureau,
Washington, April 28, 1924.

Dr. Charles G. Abbot,
Assistant Secretary, Smithsonian Institution,
Washington, D. C.

Dear Doctor Abbot: Replying to your letter of the 12th instant, I am very glad of the opportunity of expressing my views regarding the desirability of continuing the solar radiation station at Montezuma, Chile, after July, 1925.

When we remember that without the heat and light received from the sun, life on the earth would be impossible, it becomes evident that any facts that can be established relative to the sun, and especially as to the rate at which it radiates heat and light to the earth, are of fundamental importance.

With reference to the work of the Astrophysical Observatory of the Smithsonian Institution, I have already made the following statement in the Monthly Weather Review for March, 1920, page 150:

"The solar radiation investigations conducted by Doctor Abbot constitute a monumental research of the highest possible order and command only the admiration of all. * * * The whole question of short and long period solar variability, and the terrestrial response thereto in terms of weather, is obviously one of great importance to applied meteorology and to science generally. It is very necessary, therefore, that the splendid observational work done by the Astrophysical Observatory be generously supported and extended."

At this point I would like to say emphatically that I consider the systematic and continuous observation of the intensity of solar radiation to be of basic and fundamental importance, and I think it is a mistake to try to justify these observations on the ground that they will enable us to improve the forecasting of the weather from day to day. We do not know as yet what may be the ultimate practical value of the knowledge to be gained by a long series of observations, but the collection of the observations is necessary because the data constitute important facts of a fundamental, scientific character, and are pretty certain ultimately to have important practical applications to the welfare of man. The basic research is fully justified on its own merits, leaving the practical application of the information gained to be developed in the future.

For the determination of the law of the variability of solar radiation continuous observations are required for a long period of years at two or more stations as widely separated as possible. The stations of the Astrophysical Observatory at Montezuma, Chile, and on Mount Harqua Hala, Ariz., seem to be admirably adapted for this observational work, and the observatory staff has the requisite skill and experience to handle the delicate apparatus required and make the necessary complicated reductions. The small sum required to maintain the station at Montezuma, now that it is equipped, will in my opinion be money well invested.

Very truly yours,

C. F. Marvin, *Chief of Bureau.*

Doctor Simpson, director of the Meteorological Office of the Air Ministry of Great Britain, replied:

Meteorological Office, Air Ministry,
Adastral House, Kingsway,
London, W. C. 2, May 14, 1924.

Dear Doctor Abbot: I have received your letter dated April 12 asking for my opinion regarding the desirability of maintaining the Montezuma solar station after July, 1925.

Surely on this matter there can be no two opinions. The fluctuations in the amount of radiation emitted by the sun, which you and your collaborators have demonstrated, are of such fundamental importance to astronomical, geophysical, and meteorological science that I can not imagine scientific opinion resting satisfied unless arrangements are made for observing and recording these fluctuations. That we are not able at the moment to apply the knowledge gained to clearly demonstrated, practical, and economical purposes does not weigh at all with scientific opinion. If astronomical research is a fit subject for the expenditure of money, the branch of astronomy concerned with the variation of solar radiation can not be allowed to suffer for want of funds. I realize that this view is open to the attack that if the work is of so much importance to the rest of the world why should America be called upon to provide all the funds. My only reply is that, in the existing state of the world, if America does not supply the funds the work will cease. This is a fact and must be recognized as such.

There is still the question as to the necessity for two stations. Past experience affords the best answer to this question. When you first observed the large fluctuations they were so contrary to general expectation that they could not be credited until they had been confirmed by entirely separate observations, taken under largely different climatic conditions. The simultaneous observations at Montezuma and Harqua Hala have demonstrated the reality of the changes.

In the future when other changes are investigated, especially the smaller day to day changes, the same desire for confirmation will be felt if only one station is in operation. I, therefore, think that it will be a great loss to science, to civilization itself, if the Montezuma station is closed before another equally good station is established to check the observations made in Arizona.

Yours sincerely,

G. C. Simpson.

INCREASED APPROPRIATIONS

Although disallowed by the Bureau of the Budget, the increase was favorably acted upon by the Congress. Hence from and after July 1, 1925, the salaries and part of the other expenses of Montezuma Observatory have been carried on the Astrophysical Observatory appropriation. The costs of maintenance of the solar-radiation work as a whole are still supplemented to the extent of about $5,000 per annum from the income of the Hodgkins fund of the endowment of the Smithsonian Institution.

As heretofore the daily solar-constant values from Montezuma have been received at Washington by cable. Until December 31, 1925, they were forwarded daily to Mr. H. H. Clayton at Canton, Mass., to promote his studies of the dependence of weather on solar variation. Beginning January 1, 1926, at the request of the Chief of the United States Weather Bureau, the solar-constant data have been published upon the daily weather map. Also they have been furnished to Science Service, and, whenever requested, to the telegraph companies in accordance with the following announcement:

Beginning January 1, 1926, the Smithsonian Institution will furnish gratis through the United States Weather Bureau, through either of the telegraph companies, or through the Associated Press, or Science Service, if any or all of these organizations shall request it for the use of their clients, daily or 10-day mean values of the solar constant of radiation as early and as frequently as results are available from its field stations in Chile and California. In general, results are available about 24 hours after the field observations. The Institution declines, however, to furnish regularly data of this kind to individuals who may request them, since this would be in the nature of discrimination as between citizens, and, besides, too burdensome for the Institution's staff.

Hitherto the values sent out daily have been stated to be "Preliminary." Since October, 1925, they have come from Montezuma alone. Considerable time must yet elapse before the data will have accumulated at Table Mountain sufficiently to permit of the statistical study requisite before daily values can be received from that station. A definite revision of all work since 1920 is now in progress, and when it is done all values hitherto published, and all those hereafter to be published, will be, it is expected, in their final form.

DEFINITIVE REVISION OF MONTEZUMA DATA

As already remarked, much of the time of the director, Doctor Abbot, of Mr. Aldrich, and of the instrument maker, Mr. Kramer, was employed in connection with the preparations for the National Geographic Society Solar-Radiation Expedition Cooperating with the Smithsonian Institution. This expedition will result in a very great increase of the value of the work of the two existing stations, by confirming or correcting their indications of solar variability.

The remainder of the staff at Washington, comprising Mr. F. E. Fowle and Mrs. Bond, aided lately by Miss Marsden, who is employed at the cost of private funds, have been at work on a complete revision of all Mount Montezuma data. The reasons for this are: (1) That with improved apparatus the basis for the existing "short method" tables had been modified; (2) that various improvements of methods of reduction have been discovered; and (3) that with a longer series of observations now available it is possible both to draw better curves for the "short method," and to more accurately determine the systematic corrections required to eliminate traces of error still remaining on account of atmospheric haziness and humidity.

For these purposes about 125 days were entirely remeasured and fully rereduced by Langley's fundamental method, used with newly devised precautions for exact results. From the excellent values of atmospheric transmission coefficients resulting, combined with a newly contrived function of atmospheric brightness and humidity, from which all influences of solar variation were removed by introducing for the first time the pyrheliometer reading as a factor, a new basis was laid for the "short method." Among other very valuable improvements the corrections for those regions of the spectrum, not daily observed, which lie in the far ultra-violet and far infra-red, were redetermined.

As a result of all this painstaking work, the newly derived solar-constant values show in their accordance, as well as in the various internal evidences which their computations afford, that they are of a new and higher order of accuracy than ever reached before.

SELECTIVE PYRHELIOMETRY

Many writers having expressed doubt as to the certainty of variations of the sun, either of short or long interval, a new and simple proof has been formed by Doctor Abbot, and will be published in the Monthly Weather Review for May, 1926. It rests on the basis that if the atmosphere had uniform temperature, transparency, and humidity, and if the sun was observed by means of the pyrheliometer, always at the same altitude above the horizon, then the solar constancy or variation would exhibit itself directly, without recourse to the complex observations and computations associated with the bolometer. In other words, at such times the atmosphere could be regarded as a screen of unchanging influence, and the readings of the pyrheliometer would be directly proportional to the intensity of solar rays.

Testing this new idea on all the observations made in the months of July at Mount Wilson, Calif., between the years 1910 and 1920, Doctor Abbot found it necessary to exclude the years 1912 and 1913 on account of the veiling effect of dust from the volcano, Mount Katmai. Many individual days were excluded also from each July, because the atmospheric conditions differed too much from the usual ones.

From the remaining observations was plotted the full curve of Figure 2. Taking the identical days used in this study, the mean solar-constant values as heretofore published in Volume IV of the Annals give the dotted curve.

Both curves agree very harmoniously except in 1914, when they differ by about 1 per cent. They unite to indicate a range of solar variation in July, 1910 to 1920, of over 2 per cent. Along with them is plotted in a double line the variation of sun-spot numbers. Even in details the agreement is quite remarkable.

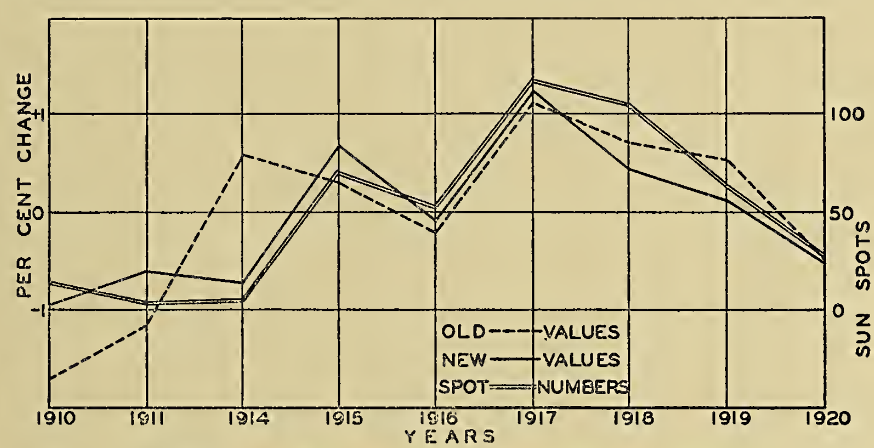

FIGURE 2.—Solar variation confirmed by results of selected pyrheliometry

Mount Wilson data of July, 1910–1920, excluding 1912, 1913, when volcanic dust from Mount Katmai made sky conditions not comparable.
Thin full curve, pyrheliometry of selected days.
Dotted curve, solar-constant values hitherto published.
Double curve, sun-spot numbers.

From another arrangement of the same data, Doctor Abbot found that those individual days on which the sun's rays appeared to the pyrheliometer more intense (when observed through unchangingly transparent atmospheres), appeared to yield on the average higher solar-constant values, as heretofore published. Similarly low days for the pyrheliometer, were low for the solar constant. Thus is confirmed by this new test the reality of both long-and short-interval solar variations. The test is not, however, as satisfactory in the latter as in the former application. As the new method has other valuable applications, it is being used also with all Montezuma and Harqua Hala observations since 1920.

PERSONNEL

The present personnel of the Astrophysical Observatory is as follows:

Director, Dr. C. G. Abbot.
Research assistant, Mr. F. E. Fowle.
Research assistant, Mr. L. B. Aldrich.
Field director, Mr. A. F. Moore.
Field director, Mr. H. B. Freeman.
Assistant, Mr. F. A. Greeley.
Assistant, Mr. E. E. Smith.
Instrument maker, Mr. A. Kramer.
Computer, Mrs. A. M. Bond.

SUMMARY

In three promising directions the work of the observatory, aimed to secure accurate determinations of solar variability, has been promoted. 1. The National Geographic Society has undertaken to equip and support for several years a cooperating solar-radiation station at the best location available in the Eastern Hemisphere. This project is rapidly going forward, and observations may begin at Mount Brukkaros, Southwest Africa, by October, 1926. 2. By Mr. J. A. Roebling's generosity, the station at Mount Harqua Hala has been removed and reestablished on Table Mountain, Calif., 2,000 feet higher, and much more favorable for observing as well as much less isolated than Mount Harqua Hala. Improved apparatus and methods were introduced there from the beginning of observations, in October, 1925. 3. A complete revision of all Montezuma observations is well advanced. New methods of measurement and reduction are employed identical with those introduced at Table Mountain. The results thus far reached show greatly superior accuracy.

By a new and simple test, the reality of solar variation is confirmed. At the recommendation of the National Academy of Sciences and of eminent astronomers, physicists, and meteorologists, the Congress has increased its appropriations for the Astrophysical Observatory sufficiently to enable the Smithsonian Institution to continue the two field observatories at Montezuma and Harqua Hala.

FISCAL YEAR 1926–27

WORK AT WASHINGTON

Radiometer improvement.—With the cooperation of the Bureau of Standards whose glass blower, Mr. Sperling, made the difficult glass work needed with glass-sealed optical windows, preparations were made to construct a very sensitive radiometer. It will be recalled that in October, 1923, Dr. C. G. Abbot employed a radiometer prepared by Nichols and Tear, and, observing with the 100-inch telescope on Mount Wilson, obtained the first energy spectra of stars ever measured with heat-recording apparatus. In 1924 he attempted to improve on these first results by constructing a lighter system, using flies' wings to prepare the vanes of the instrument. But he found that at the air pressure required to give a good radiometer deflection, the system was damped into such sluggishness as to be useless. At the suggestion of Doctor Anderson of Mount Wilson Observatory, Doctor Abbot proposed to substitute hydrogen for air, hoping to get equal sensitiveness and much less damping. As hydrogen would be contaminated by air leakage, or cock grease, or mercury vapor if connected with an air pump, as usual, he proposed to seal up the suspended system in glass like an X-ray tube, having first exhausted the glass case as completely as possible, and filled in pure hydrogen (through a liquid air trap) to the desired pressure.

The necessity of rotating the suspended system with reference to the glass case and its optical windows offered difficulties. However, this was accomplished by including within the case a train of gearing ending in a little horseshoe magnet, which could be rotated by another magnet from without. The reduction of speed from the magnet to the suspension system was in all nearly 10,000-fold, so that a little reversible electric motor, with cone drive, was arranged to drive the outside magnet through so many thousands of turns. All of these contrivances were constructed by Mr. Kramer under Doctor Abbot's direction, but the actual expedition to Mount Wilson did not go forward until July, 1927, and will be described in the report of 1928. It may be worth while to add, however, that Mr. Aldrich tested occasionally for 10 months, by weighings, the evaporation of a large surface of beeswax laid down on thin mica. The loss was so very slight that this substance was found quite suitable to fasten the parts of the radiometer suspension without fear of appreciably contaminating the hydrogen by mixture of its heavy molecules.

Pyrheliometer vestibule.—Although the Californian and the Southwest African equipments had been supplied with silver-disk pyrheliometers with very long vestibules to cut down the effect of atmospheric radiation immediately surrounding the sun, and though all of our observatories have been equipped with half-second pendulums to reduce error in time observations at the pyrheliometers, yet we are seeking a degree of accuracy so high that an attempt seemed desirable to devise a new type of pyrheliometer in which errors would be still more reduced. This instrument was not entirely completed at the close of the period of this report, and its performance will be described in the report for 1928.

Completion of Montezuma revision.—The important work of revision of solar-radiation measurements mentioned in last year's report was prosecuted vigorously during the fiscal year. A complete re-reduction of all Montezuma observations from 1923 to date, including the measurement of plates for nearly 150 days of fundamental observation by Langley's method, and also the setting up of a new system of reduction for short-method observations, was completed in May, 1927. The new results, while differing on the average by only a small fraction of 1 per cent from the preliminary ones, are undoubtedly of much greater weight, and may now be regarded as definitive. A full description of the processes and the reasons for them will eventually be published.

A similar study of all Table Mountain observations is going on, and, when completed, definitive observations will be published from that station also.

Readers may understand the necessity of these revisions of solar-radiation observations by recalling that in astronomy the late Prof. Lewis Boss spent many years in a revision of all high-class observations of the positions of stars and introduced numerous corrections to the individual observations, based on extensive

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statistical study, before he was able to combine the whole study into his "Classical Preliminary General Catalogue." A similar statistical study of our solar observations could not be made until several years of homogeneous measurements were available. It would have been better to have waited for 10 years before making it, but the urgent demands of meteorologists for our solar observations have induced us to try to put the matter in definitive form thus early.

Smithsonian exhibition of February 11, 1927.—In connection with the conference of eminent men on the future of the Smithsonian Institution, the Astrophysical Observatory, as well as other departments, was represented by an exhibit of working instruments, diagrams, and photographs. In order to give as complete and striking a picture as possible of the purposes and attainments of the observatory, a very considerable amount of time of the director, of Mr. Aldrich, and of Mr. Kramer, was devoted thereto.

FIELD WORK

Table Mountain, Calif.—This observatory, which by Mr. John A. Roebling's generosity was erected in the autumn of 1925 to replace that on Mount Harqua Hala, has been in continuous observation of the solar constant of radiation during the fiscal year. While the number of days available for observation does not very greatly exceed the number at Harqua Hala, the quality of these days, especially in the months of June, July, August, and September, is immensely superior. On one occasion in the autumn of 1926 Mr. Moore was able to observe at Table Mountain on 71 consecutive days, which is by far the maximum record for any of our stations. As stated above, a definitive reduction of all Table Mountain observations is being vigorously pushed.

Montezuma, Chile.—This, our best solar-constant station, was also in continuous observation during the entire year. Its daily results were published on the United States weather maps of the next following days; also, telegraphic advices were sent daily to the Argentine Government and to Dr. Julio Bustos Navarette, who publishes a monthly meteorological bulletin containing them.

As stated above, a definite re-reduction of the Montezuma work has been completed, and the results are now being published in final form.

At the suggestion of Doctor Dobson, of Oxford, England, a copy of his atmospheric ozone measuring apparatus has been installed at Montezuma, and its daily results are forwarded to Doctor Dobson for reduction and publication.

Mount Brukkaros, Southwest Africa, station established.—The solar-radiation expedition of the National Geographic Society, in cooperation with the Smithsonian Institution, was fully equipped and sent forward in August, 1926. Meanwhile, the observatory itself was being prepared by Mr. Dryden, of Keetmanshoop, Southwest Africa, under Government auspices. A little later a telephone line was installed by Colonel Venning, director of posts and telegraph, of Windhoek.

The expedition (W. H. Hoover, director, F. A. Greeley, assistant) reached the mountain in October, 1926, made preliminary observations in November, and began regular daily observing in December.

It is yet too early to decide how satisfactory atmospheric conditions at this observatory will prove to be. During a considerable part of the time they have been first class. Old residents maintain that during the unfavorable time the weather has been unusual, and that other years will prove much better. This view is supported to some extent by the weather of Montezuma, Chile, which seems to be in some degree parallel. Atmospheric conditions have undoubtedly been unusually bad at Montezuma during the times when Mount Brukkaros reported unfavorable conditions.

PERSONNEL

The present personnel of the Astrophysical Observatory is as follows:

Director,[2] Dr. C. G. Abbot, Washington.
Field director, Mr. A. F. Moore, Table Mountain.
Field director, Mr. H. B. Freeman, Montezuma.
Field director,[3] Mr. W. H. Hoover, Mount Brukkaros.
Research assistant, Mr. F. E. Fowle, Washington.
Research assistant, Mr. L. B. Aldrich, Washington.
Field assistant,[3] Mr. H. H. Zodtner, Table Mountain.
Field assistant,[3] Mr. E. E. Warner, Montezuma.
Field assistant, Mr. F. A. Greeley, Mount Brukkaros.
Computer, Mrs. A. M. Bond, Washington.
Computer, Miss M. A. Marsden, Washington.
Computer,[3] Miss M. C. Rhoderick, Washington (temporary).
Instrument maker, Mr. A. Kramer, Washington.
Librarian,[3] Mrs. M. L. Reed, Washington (temporary).
Librarian,[3] Mrs. A. E. Blanchard, Washington (temporary).
Librarian,[3] Miss M. B. Ladd, Washington (temporary).
Librarian,[3] Miss C. S. Gunther, Washington (temporary).

SUMMARY

The work of the year was mainly in continuation of accurate observations of the solar-constant of radiation. A new cooperating observatory in Southwest Africa was installed at the cost of the National Geographic Society. Improved apparatus and procedure has led to a higher standard of accuracy in all the observatories than ever before.

Gratifying correlations with other results are appearing. Thus Doctor Pettit's observations of ultra-violet solar radiation, while showing extreme variations of at least a hundred per cent, are closely in proportion with the small changes

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[2] Compensation defrayed in part from private funds.
[3] Compensation defrayed in part or wholly from private funds.

found in total solar radiation by the Smithsonian observers. Doctor Austin, too, finds a very high correlation between solar-constant changes and the reception of long range radio.

Periodicities in solar variation.—Finally, a remarkable regular periodicity of 25⅜ months has been found by Dr. C. G. Abbot in the solar variation itself, which, during the years 1920 to 1927, has joined with the sun-spot cycle to account for almost the whole change in monthly mean solar-constant results. If this persists in future years, it may become possible to forecast at least two years in advance the principal solar changes, and whatever of importance may prove to hang thereon.

FISCAL YEAR 1927–28

WORK AT WASHINGTON

Three field stations—Table Mountain, Calif.; Montezuma, Chile; and Brukkaros, Southwest Africa—are now steadily sending results of daily observations of the intensity of solar radiation to the Smithsonian Institution. The work of comparing these observations, of detecting and determining sources of error, and correcting therefor, and the care of keeping the three stations, thousands of miles away in the wilderness, supplied with material and personnel has occupied much time of the director and staff in Washington.

Several years having gone by since the station at Table Mountain began its regular work, enough data had accumulated to justify a statistical study over the whole period, to detect any systematic errors. Minute systematic errors in the uncorrected results are inevitable. We are attempting to determine the intensity of the sun's energy not only as it is received at the observatory but also as it was in free space outside the atmosphere. Humidity and dust produce effects which it is impossible to ascertain precisely on any given individual day by any method. Hence only by comparing the average run of the results over a term of years with the average run of atmospheric conditions during the same interval can these not quite negligible residual systematic errors be determined and allowed for. Such a study of the Table Mountain work has been in progress. When completed there were revealed certain discordances between Table Mountain and Montezuma which, though small, demanded still further study.

Ozone and the solar constant.—As so often has happened in the history of science, this study by my colleague, Mr. Fowle, of a perplexing discordance has brought a new discovery of some importance. It is that the ozone existing in the atmosphere at a level of 30 to 50 kilometers (18 to 30 miles), and which is formed from the atmospheric oxygen by the action of invisible ultra-violet sun rays, is variable in amount over Table Mountain, though nearly constant in amount over Montezuma. The discrepancy in the final results of radiation work between the two stations appears to be due mainly to this variability of atmospheric ozone at Table Mountain.

Regular observations of ozone are now in progress there in cooperation with Doctor Dobson, of Oxford, England.

The tedious but necessary computations and statistical comparisons involved in the work of systematizing and correcting the preliminary results of the observations, only part of which is indicated in the discussion above, have employed Mr. Fowle and two computers continually during the year.

Apparatus.—Under the direction of the writer and his colleague, Mr. Aldrich, the instrument maker, Mr. Kramer, has continued to make apparatus for radiation investigations. One instrument upon which much attention has been lavished is a new form of pyrheliometer to measure more accurately and conveniently the sun's radiation. So accurate and stable is the silver-disk pyrheliometer which we have employed for nearly 20 years, and of which over 50 copies have been furnished by the Smithsonian at cost to other institutions at home and abroad, that it is hard to prepare a new instrument superior to it. Yet there are two or three slight sources of error, and a certain slowness of reading characteristic of the silver-disk instrument which it is hoped to improve upon. Thus far the new instrument, of a compensating electrical type, has not quite reached expectations, but it is still hoped to overcome its deficiencies and retain its advantages.

Attention was also paid to the improvement of the radiometer for measuring the energy of the spectra of the stars. In this instrument it was proposed to seal the sensitive element in a truly circular, optically figured quartz tube containing a small pressure of hydrogen, and to adjust the position and direction of the system by moving and rotating the inclosing cylinder. The device was made ready for use by the writer during the summer of 1928 at Mount Wilson, Calif., with good results, which will properly be described in next year's report.

In connection with a research by Mr. Aldrich on the radiation and convection of the normally clothed human body, a number of instrumental appliances were also made.

Radiation of the human body.—Inquiry was made of the writer by Mr. T. J. Duffield, secretary to the New York Commission on Ventilation, as to the proportion of the loss of heat of the normally clothed human body which should be ascribed to radiation rather than to convection by the air. The subject needed investigation, and at the writer's suggestion a grant of $1,000 was made by the New York Commission on Ventilation to the Smithsonian to promote it. My colleague, Mr. Aldrich, undertook the work and made several long series of novel and valuable experiments, the results of which will shortly be published.[4] He employed principally two instruments: First, the melikeron, or honeycomb pyranometer, for observing radiation of bodies at low temperature, first described in these reports for the years 1919 and

[4] Aldrich, L. B., A study of body radiation. Smithsonian Miscellaneous Collections, vol. 81, no. 6, 1928.

1920; and second, a special thermoelectric temperature tester constructed for the research.

Mr. Aldrich sums up his results as follows:

(1) The radiation from the skin and clothing is approximately that of a "black body" or perfect radiator.

(2) Skin temperatures computed from melikeron radiation measurements are about 1° C. higher than skin temperatures measured directly with the thermoelement. This is not true on clothing of calorimeters. Apparently the melikeron sees deeper into the pores of the skin than the level observed by the thermoelement.

(3) A cloth-covered, vertical, cylindrical calorimeter at body temperature loses in still air 60 per cent by radiation, 40 per cent by convection. A similar horizontal calorimeter loses 54 per cent by radiation, 46 per cent by convection. The human body convection loss is probably similar to this; that is, the convection loss is roughly one-third less than the radiation loss in still air and normal room temperatures.

(4) Increasing air motion rapidly decreases the percentage radiation loss and increases the convectional. With the vertical calorimeter:

Air motion:	Per cent radiation loss
0	60
75 feet per minute	41
130 feet per minute	35
190 feet per minute	25

(5) Total body radiation similarly decreases with air motion:

Air motion:	Radiation loss (mean for 10 subjects)
0 to 50 feet per minute	30.7 large cal. per sq. m. per hour
50 to 100 feet per minute	29.3 large cal. per sq. m. per hour
100 to 150 feet per minute	25.7 large cal. per sq. m. per hour
180 to 250 feet per minute	23.2 large cal. per sq. m. per hour

(6) Increase in room temperature (which also means increase in wall temperature) produces a progressive lowering of radiation loss. The ratio $\frac{\text{Radiation loss}}{\text{Basal metabolism}}$ decreases with increase of room and wall temperature:

Radiation loss

	Room temperature	$\frac{\text{Radiation loss}}{\text{Basal metabolism}}$
Table L	21°. 3	0.80 (mean of 10 subjects).
	24°. 1	0.75 (mean of 10 subjects).
Table J	22°. 1	0.84 (mean of 3 subjects).
	24°. 5	0.74 (mean of 4 subjects).
	25°. 6	0.66 (mean of 3 subjects).

(7) Keeping room and wall temperatures unchanged, the temperature of the skin and clothing decreases with increasing air motion, the decrease being greatest on the side facing the wind and about one-half as great on the side away from the wind. The clothing temperature drop on the side toward the wind is about one-third greater than the corresponding skin temperature drop. Summary of 10 subjects:

Air motion (feet per minute)	Skin temperature drop		Clothing temperature drop		
	Away from wind	Toward wind	Away from wind	Toward wind	Perpendicular to wind
0 to 100	−°. 4	−°. 8	−°. 6	−1°. 3	−°. 5
100 to 250	−°. 7	−1°. 2	−°. 4	−1°. 7	−°. 5

(8) At normal indoor temperature, in still air and with the subject normally clothed and at rest, body-heat losses are distributed as follows:

	Per cent
Evaporation of water	24
Radiation	46
Convection	30

(9) Tests with the thermoelement show that the air temperature falls to room temperature very rapidly as the distance from the body increases. That is, there is a steep temperature gradient in the first centimeter or so from the body surface. With the thermoelement 30 cm. away no effect of the presence of the body could be detected.

(10) The Abbot-Benedict work (Table A)[5] indicates that the radiation loss from a nude subject is about twice as great for a room temperature of 15° as it is for a room temperature of 26°. This evidence does not entirely support the "suit-of-clothes" theory referred to by DuBois. In explanation of this theory, he says (p. 385, 1927 ed. Basal Metabolism): "A constriction of the peripheral blood vessels (occurs) and the amount of heat carried to the surface is relatively small in proportion to the heat produced. * * * The patient really changes his integument into a suit of clothes and withdraws the zone where the blood is cooled from the skin to a level some distance below the surface."

(11) Normal fluctuations in humidity indoors produce negligible effect upon the radiation loss. This is to be expected. Our bodies, about 300° absolute, radiate almost wholly between the wave lengths 4μ and 50μ with a maximum at 10μ. Water vapor absorption is so strong for much of this range and so nearly negligible near the maximum, that its possible effect is nearly fully produced, even by the humidity of an ordinary room. Thus the effect of changes of quantity of water vapor in the ordinary room is small. Were the air of the room exceedingly dry, changes might be noticeable.

[5] Not here reproduced.

WORK IN THE FIELD

As far as possible, daily measurements of the intensity of solar radiation have been made at the Smithsonian stations at Table Mountain, Calif., and Mount Montezuma, Chile. Also similar measurements have gone on regularly at the cooperating station of the National Geographic Society on Mount Brukkaros, Southwest Africa.

Pending completion of the statistical investigations of the results of the two last-named stations, as mentioned above, only the results obtained at Mount Montezuma are being published at present. By continued cooperation of the United States Weather Bureau, the daily telegraphed values of the solar constant of radiation are being regularly published on the Washington daily weather map.

As tentatively and privately forecasted in November, 1927, on the basis of hitherto observed periodicities in solar phenomena, the "solar-constant" values reached a high level in the spring months of 1928, and were expected to reach a low level in the autumn.[6] Much interest attaches to these tentative forecasts of the solar energy to be expected for long periods in advance, but several years must yet elapse before (if ever) they can be made with sufficient confidence to justify publication.

Although the solar-radiation measurements have been reduced to a routine for several years at all our stations, the very high degree of accuracy now demanded and generally achieved is occasionally marred by new and unexpected accidents and difficulties. Thus internal evidence disclosed that some obscure error of very considerable amount began in August, 1927, to affect the sky-radiation measurements of the pyranometer on Table Mountain. Our best thought and many experiments had failed to disclose the obscure cause up to the close of the period of this report, but by anticipation I may say that at this time of writing (October 3) the error has been detected, cured, and a beginning has been made to eliminate its influence from the final results of the observations. This circumstance has prevented us from making public Table Mountain results hitherto.

Dobson ozone apparatus installed.—Doctor Dobson, of Oxford, England, having perfected a spectroscopic method for determining the quantity of atmospheric ozone, has found that quantity variable in most interesting relations to solar phenomena and to weather. He has established a chain of cooperating observatories in Europe, and, by aid of a grant from Mr. John A. Roebling, the Smithsonian was able to equip the Montezuma station with the necessary apparatus. For about one year daily measurements were made at Montezuma by Field Director Freeman, aided by Mrs. Freeman. The photographs taken were reduced in England by Doctor Dobson and his colleagues, but, contrary to European experience, showed

[6] At this writing (October 3), this latter forecast also has been supported by September results.

almost zero variation. They also showed a much smaller quantity of atmospheric ozone at Montezuma than in Europe.

Finding further observations at Montezuma unnecessary because of the uniformly constant results, the apparatus was returned to Oxford, restandardized, and sent to Table Mountain, Calif., where it is now installed for daily observing.

Radiometer improvement.—As stated in last year's report, the writer undertook at Mount Wilson, in the autumn of 1927, to continue radiometer measurements of the distribution of energy in the spectra of the stars. This work was made possible by the availability of the 100-inch telescope of the Mount Wilson Observatory. It had been proposed to substitute hydrogen for air in the radiometer, on the theory that the radiometer reaction would be nearly the same, but the damping and consequent sluggishness of action would be much diminished in so light and free-moving a gas as hydrogen.

Arriving in July, 1927, at Pasadena, the writer constructed the radiometer vanes from bits of house-flies' wings. Incidentally it was observed that it requires about 6,000,000 house-flies' wings to weigh 1 pound. With a fragment of microscope cover glass (ground and polished to about one-third the usual thickness) the mirror of the radiometer system was prepared. Two such systems of unequal, but both of almost microscopic size, were hung upon quartz fibers so fine as usually to be invisible, and were tested in air and in hydrogen at various pressures. With them was used also a bolometric element designed to give basis for an estimate of the comparative rise of temperature of the radiometer vanes, when exposed to a constant source of radiation, but contained in the different test gases.

Hydrogen proved somewhat less efficient in regard to rise of temperature and radiometer reaction than air, but abundantly justified the expectation that its damping properties were much less objectionable. On the whole, hydrogen appeared greatly superior as the radiometer gas, and a carefully built system, with vanes 0.35 millimeters wide and 1 millimeter tall, was constructed. It had three vanes in parallel on either side of the stem, separated 1 millimeter between centers. This system was sealed into a glass [7] case in hydrogen under 0.23 millimeter pressure of mercury. Provision had been made to rotate the system by a magnetic device.

After many trials, the device proved useless, because the mechanism required to rotate the system so as to bring it to face in the proper direction so stirred up the gas that wholly unexpected motions resulted. After much labor the experiment was given up for the year 1927.

For use in 1928, at Doctor Adams's suggestion, there was prepared an optically figured quartz cylindrical vessel. This fused quartz cylinder, of beautiful clearness,

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[7] I am greatly indebted to the director and staff of the Bureau of Standards, especially Mr. Sperling, and to the director and staff of the Mount Wilson Observatory, especially Mr. Pompeo, for the construction of the special glass apparatus and the preparation for its use on Mount Wilson.

was made to my order by the General Electric Co., and was figured within and without at the Mount Wilson Observatory shop. Being truly a circular cylinder with optically figured concentric walls, it mattered not at all in what direction the radiometer looked out. Thus by mounting the whole cylinder from a brass support, rotatable in a ground joint, the radiometer could be inclosed in an airtight outside case of brass having windows, toward which the radiometer could at any time be made to look out by merely rotating the brass piece in its well-ground seat.

With this simple but adequate apparatus the Mount Wilson expedition was renewed by the writer in 1928, with a high degree of success, which must be related in next year's report.

PERSONNEL

During the year the personnel has been as follows:

At Washington:
- *Director,* Dr. C. G. Abbot.
- *Research assistants,* F. E. Fowle, Jr., L. B. Aldrich.
- *Temporary assistant,* M. K. Baughman.
- *Computers,* Mrs. A. M. Bond, Miss M. A. Marsden.
- *Instrument maker,* A. Kramer.

At Table Mountain:
- *Field director,* A. F. Moore.
- *Field assistants,* H. H. Zodtner, H. B. Freeman.

At Mount Montezuma:
- *Field directors,* H. B. Freeman, H. H. Zodtner.
- *Field assistants,* E. E. Warner, M. K. Baughman.

At Mount Brukkaros:
- *Field director,* W. H. Hoover.
- *Field assistant,* F. A. Greeley.

SUMMARY

A novel research on the relative cooling of the human body by radiation and by air convection has yielded unexpected and valuable results. Improvements in instruments include a new form of sensitive radiometer in which by the substitution of hydrogen for air a great increase in quickness of response permits the use of excessively light systems and promises a great development of sensitiveness. Continued progress in the reduction and systematization of the results of solar-radiation work have brought the study of the ozone content of the atmosphere as a new element in the determination of the solar constant of radiation. Daily observations have been continued at Table Mountain, Calif., Mount Montezuma, Chile, and (in cooperation with the National Geographic Society) at Mount Brukkaros, Southwest Africa. By cooperation with the United States Weather Bureau, daily publication of the values of the solar-constant of radiation for the use of meteorologists has been effected.

FISCAL YEAR 1928–29

WORK AT WASHINGTON

Continuous series of solar observations having been made as hitherto at several field stations on desert mountains in distant lands, these observations have been critically studied and prepared for publication at Washington. Several new investigations based on these observations have been made and published and we have carried on the preparation and standardization of apparatus. Details follow.

Periodicities in solar variation.—Observations at Montezuma, in Chile, had been reduced to a consistent and definitive system several years since. This system requires no computations beyond those which the observers make regularly in the field. Telegrams in code are received daily from Montezuma, and when decoded are communicated to the United States Weather Bureau, which publishes on the Washington daily weather map the solar-constant value observed 24 hours previously at Montezuma.

In November, 1928, Doctor Abbot assembled the monthly mean solar-constant values of 101 consecutive months ending with October, 1928, and plotted them in the form of a curve. This curve Dr. Dayton C. Miller, of Cleveland, was kind enough to analyze by means of his ingenious and accurate machine, so as to bring out the first 30 harmonic constituents, which, combined, approximately represent the original curve.

From a previous analysis of 77 months, made in 1926, it had appeared that periods of about 26, 15, and 11 months and the submultiples of these periods were all the periods under 26 months that seemed to have continuous existence in the solar variation. Accordingly, the interval of 101 months had been purposely chosen as nearly a common multiple, so that if these periods were still persistent they might be brought out as approximately the fourth, the seventh, and the ninth harmonics, with their overtones.

Figure 3 shows the result of this analysis. The zigzag line represents the original monthly mean of observations, and the 30 sinuous curves below are the harmonics. Until a longer interval of observation shall be available for analysis, it is not considered desirable to discuss periodicities longer than 10¼ months. The reader will perceive that if we therefore neglect the march of the first, second, and third harmonics, the fourth, its overtones the eighth, twelfth, and sixteenth; the seventh, its overtones the fourteenth, twenty-first, and twenty-eighth; and the ninth and its approximate overtones the nineteenth and twenty-seventh are really the most prominent features, whereas some of the other harmonics, such as the fifth, sixth, tenth, eleventh, thirteenth, seventeenth, eighteenth, twentieth, twenty-fourth, twenty-sixth, and twenty-ninth, not included in these three series of overtones, nearly vanish. Indeed, apart from those named in connection with the fourth, the

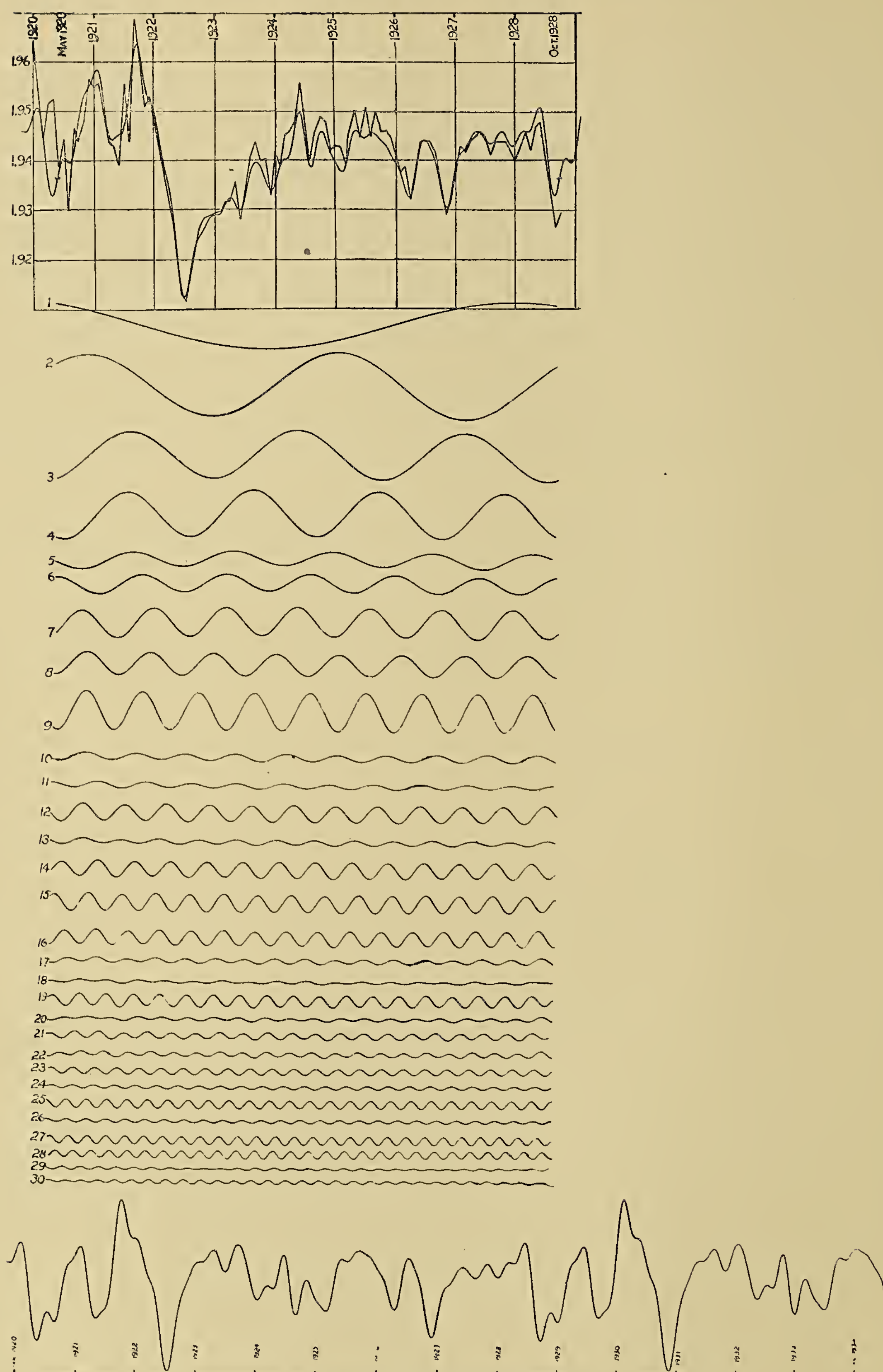

FIGURE 3.—Periodicities in solar variation

seventh, and the ninth, only the twelfth, fifteenth, twenty-third, and twenty-fifth seem to be of appreciable significance. This suggests that the third and its overtones may also have real significance. It is of great interest to note that the periods corresponding to the fourth, the seventh, and the ninth harmonics, which we find so well marked in solar variation, have also been particularly noted by students of the march of weather and crop phenomena.

Assuming that the harmonics from the fourth to the thirtieth represent all the real regular periodicities in the variation of solar radiation, the curve B, at the foot of the diagram, which is their summation, represents the march of this periodic part of solar variation. Continuing it to cover the years 1929, 1930, and 1931, we are led to anticipate features of uncommon interest in the march of solar variation in the period just approaching. It will, indeed, be exceedingly interesting to see to what degree this forecast is verified.

Reduction of Table Mountain observations.—Observations at Table Mountain, Calif., which have continued since December, 1925, have been critically studied at great length during the past year by Mr. Fowle and the computers. Mr. Fowle has considered that the results might be affected by three variable atmospheric elements—the water vapor, the haze, and the ozone which occurs in the very high atmosphere. It was easy to arrange the data in groups corresponding to gradual increase of quantities of atmospheric water vapor, for this vapor is readily measured and expressed as total precipitable water by Fowle's method which he worked out from spectroscopic study in the laboratory many years ago. By such statistical arrangement, corrections for precipitable water were sought.

However, there is one obstacle depending on the contemporaneous real variability of the sun which hinders immediate estimation of water-vapor influence. True, this solar variability might have been eliminated by employing the definitive results of Montezuma, but we avoided this procedure, since, in the opinion of some, it might not have left the Table Mountain observations fully independent. Accordingly, the solar variation was roughly estimated from Table Mountain pyrheliometry alone, after the method referred to in my report for 1926, page 116. Allowance was thus made for the solar variation before determining the water-vapor effect.

Pyranometry error.—When these steps had been taken it became clear that a sudden increase of the Table Mountain solar-constant values had been indicated about August 12, 1927. This change of scale continued with apparently increasing departures thereafter. No parallel result having been noted at Montezuma, every contributary element of the measurements at Table Mountain was investigated to learn the source of the discrepancy. It was soon found that the change was due to a large change in the scale of pyranometer measurements of the brightness of the sky near the sun. Yet redeterminations of the constants of the pyranometer itself by observing solar radiation with it gave excellent agreement with previous values. Very numerous experiments and comparisons were made at Table Mountain in the effort to trace the cause of the discrepancy. These were without result until September, 1928, when Doctor Abbot visited the station and observed that portions of the vestibule of the instrument had become shiny by handling. Hence sunlight in addition to sky light was reaching the sensitive measuring strip. By reblackening the limiting diaphragm nearly all of this error was removed.

It was now necessary to perform a great mass of statistical computing in order to determine the magnitude of the pyranometer error at different dates. Fortunately, an error of 20 per cent in pyranometry makes but 1 per cent error in the solar constant, so that no great accuracy of determining the error was required. Hence it appeared sufficient to collect all the pyranometer values of each month, arranging them in orders of atmospheric humidity, air-mass, and pyrheliometer value, and to compare the mean pyranometer values of corresponding months in successive years, as well as the values in nearly identical sky conditions throughout each year.

It soon became clear that no change in the instrument had occurred prior to early August, 1927. At that time there had been many experimental comparisons involving handling of the vestibule, which had done the damage and led to the sudden change. Afterwards many more comparisons were made to find the trouble, and these had aggravated it. After much work it became possible to determine a set of sufficiently exact corrections to the pyranometry of 1927 and 1928 suitable to each of the 13 months during which they were needed. These studies were made on Table Mountain observations exclusively, so that they introduced no element of dependence on Montezuma.

To prevent a future mischance of this kind, imperative orders were issued to all stations as to the handling of instruments, and standard instruments, for comparison purposes only, were added to the equipment, with instructions to make fairly frequent comparisons between these and the instruments in use.

Fowle's ozone method.—Mr. Fowle, having become impressed that the variations recently investigated by Dobson in the quantity of atmospheric ozone might very possibly affect the observed solar constant, made a fruitful investigation of the absorption of ozone in the yellow and green of the solar spectrum.[8] He found that this absorption, though small, is clearly and quantitatively indicated by means of the atmospheric transmission coefficients obtained in the application of the fundamental long method of solar-constant determination invented by Langley. As we frequently employ this method at all stations as a check on the short method in daily use, Fowle was able to determine the atmospheric ozone at Calama, Montezuma, Harqua Hala, and Table Mountain on very many occasions since the year 1920.

[8] Published in Smithsonian Miscellaneous Collections, vol. 81, no. 11, 1929.

It proved, harmoniously to what Dobson had found, that the ozone above Mount Montezuma is meager and nearly invariable in quantity, but that above Harqua Hala and Table Mountain it is much more plentiful and very variable. Having compared the variations of monthly mean ozone values with the Table Mountain observations of corresponding variations of solar-constant values, Mr. Fowle found a strong correlation between them. As the yearly march of the monthly mean ozone values at these nothern stations appears to be a terrestrial phenomenon, a fact entirely harmonious to those well established by Dobson, it seemed entirely legitimate to introduce a solar-constant correction, statistically determined, to allow for ozone in much the same way as for water vapor, for the Harqua Hala values.

This having been done, and the water-vapor and haziness corrections having been applied, it was found that the absolutely independent final values of the solar constant determined at two stations 4,000 miles apart (viz, Table Mountain, 7,500 feet high, in California, and Montezuma, 9,000 feet high, in Chile) march with gratifying accord. For the *ratios* of the values determined at the two stations show no appreciable indication of a *yearly* range, although winter at the one station corresponds with summer at the other. Furthermore, the total *range* of straggle of nine-tenths of the *daily* ratios of these independent values *does not exceed 1.1 per cent.* This involves the conclusion that the *total range of accidental error* at a single station seldom exceeds 0.8 per cent, and therefore the probable value of the accidental determination of a single day at one station is less than 0.3 per cent. This being so, we are prepared to expect that both stations, though wholly independent, must concur within narrow limits in their determination of the sun's variation.

With this gratifying conclusion reached in the final discussion of the results of two independent solar-observing stations remote from each other, a point seems to be reached where it is proper to publish Volume V of the Annals of the Astrophysical Observatory, to contain the numerous observations obtained since the year 1920. Doctor Abbot has been engaged on the preparation of this text, and it is hoped that the volume will be ready to publish in the fiscal year ending June, 1931, thus including a full decade of observations.

As usual, many instruments have been constructed at Washington for research purposes. These include a number of silver-disk pyrheliometers, prepared at the expense of the private funds of the Institution, but standardized against the standard instruments of the Astrophysical Observatory, and sold at cost to research institutions of various lands.

Mr. Aldrich has assumed charge of the instrument making and standardizing. He has also continued work on the fruitful investigation of the radiation and cooling of the human body, referred to last year. In addition he has assisted in reducing solar-constant observations, and has attended to the considerable correspondence on physical and astronomical matters.

FIELD WORK

Infra-red solar-spectrum details.—Doctor Abbot spent the months of July, August, and part of September, 1928, at Mount Wilson, Calif., where he was assisted by Mr. Freeman. Besides improving the solar cooker to greatly increased efficiency, two considerable researches were carried through. The first of these is the repetition of the bolometric determination of positions of solar and terrestrial absorption lines and bands in the infra-red solar spectrum. This had formed the main subject of Volume I of the Annals of the Astrophysical Observatory. As photography has not as yet reached far beyond the extreme red of the spectrum, the best means of observing these interesting lines and bands of the infra-red lies in measuring the cooling which attends them. For this purpose a well-dispersed spectrum is caused to march slowly over a sensitive linear bolometer strip, and a continuous curve indicating its temperature is automatically recorded. As the bolometer strip falls into each successive one of the lines of the spectrum, a nick comes in the curve.

Three approximately 60° flint-glass prisms in tandem were used to disperse the solar rays, and long-focus mirrors to collimate and focus the spectrum. Five photographic plates, each 60 centimeters long, were required to cover the spectrum from "A" in the red to "Ω" in the infra-red. Mr. Freeman did most of the final observing, and also measured the plates. Over 1,200 lines and bands of absorption were discovered, where only about 550 had been found in the earlier investigation published in 1900. A paper on this new work has been published as volume 82, number 1, of the Smithsonian Miscellaneous Collections.

Energy spectra of stars.—The other research carried through was the observation of the distribution of energy in the spectra of 18 stars and of the planets Mars and Jupiter. This was accomplished by Doctor Abbot with the aid of Doctor Adams, of Mount Wilson Observatory, employing the 100-inch telescope and a sensitive radiometer.

Greatly increased sensitiveness had been hoped for by substituting hydrogen for air, and an excessively light and small radiometer system, built up with house-flies' wings, for the somewhat larger mica-vane instrument employed by Doctor Abbot in 1923. With these improvements it was hoped that stars of the fourth or even fifth magnitude would be observable. These hopes were not altogether realized. The sensitiveness was potentially attained, but, unfortunately, could not be made available during the time of the experiments because a persistent slight charge of electricity which could not be removed created a governing field, which reduced the time of single swing of the system from about 10 seconds to only 1.5 seconds during the experiments. On this account the deflections in the stellar spectra were regrettably small. Nevertheless, with the special observing scale which had been devised, very satisfactory results were reached, and in one case on a star of only 3.8 magnitude. These observations have been published in the Astrophysical Journal for May, 1929.

Montezuma station.—During the autumn of 1928 the apparatus at Montezuma seemed to grow insensitive, so that a critical inspection appeared necessary. By the generous financial assistance of Mr. John A. Roebling, it was possible to send Mr. Aldrich to Chile. This expedition occupied him from January to March, 1929. He rebuilt the galvanometer and repaired and adjusted other instruments until everything was in satisfactory condition. Excellent results have been coming in regularly of the Montezuma observations on the solar constant of radiation. These are published daily by the United States Weather Bureau.

Table Mountain station.—The unfortunate trouble with the pyranometer at Table Mountain has already been described. Notwithstanding this, the results as now reduced seem satisfactory and are very numerous. Indeed, on several occasions Table Mountain has furnished consecutive daily runs of solar-constant determinations exceeding 50 days and once exceeding 70 days.

The Dobson ozone apparatus, owned by the Smithsonian and formerly in use at Montezuma, was returned to England for readjustment by Doctor Dobson. It was reinstalled at Table Mountain in the autumn of 1928 and daily determinations of atmospheric ozone have been made with it whenever possible since then. These measurements show in contrast with those formerly made at Montezuma about as much ozone in the higher atmosphere above California as has been found in Europe. Also, in contrast with Montezuma and in harmony with Europe, they show a decidedly variable quantity of ozone from day to day and from month to month. These ozone determinations will be continued at Table Mountain indefinitely.

Mount Brukkaros station.—The National Geographic station on Mount Brukkaros, Southwest Africa, which cooperates with Montezuma and Table Mountain in the daily observation of the solar constant of radiation, has continued regular observations and has sent to Washington a large collection of records. These will be statistically and critically studied and prepared for publication.

As the observers, Messrs. Hoover and Greeley, have been three years in this African field, arrangements have been made for Messrs. Sordahl and Froiland to relieve them in August, 1929.

PERSONNEL

At the stations, Mr. A. F. Moore has continued in charge at Table Mountain and Mr. H. H. Zodtner at Montezuma. Mr. Moore was assisted mainly by Mr. L. O. Sordahl, and after his departure, in June, 1929, by Dr. W. Weniger. Mr. Zodtner was assisted until April 1 by Mr. M. K. Baughman and after his resignation by Mr. C. P. Butler.

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At Washington the force has remained unchanged, with three exceptions. Mrs. A. M. Bond resigned as computer on February 5, 1929. She was succeeded on February 18 by Miss M. Denoyer. Mr. H. B. Freeman, formerly in charge of Montezuma station, assisted at Mount Wilson and at Washington until May 1, 1929, when he obtained a transfer to the laboratories of the National Advisory Committee for Aeronautics at Langley Field, Va.

SUMMARY

The year has been notable for the satisfactory continuation at field stations of observations for the study of the variability of the sun; for the satisfactory completion of the critical statistical investigation of the results obtained at Table Mountain, so that hereafter Table Mountain observations may be definitively reduced by field observers; for the excellent accord found between definitive results of Table Mountain and Montezuma (stations 4,000 miles apart in opposite hemispheres) in their indications of solar variability; for the apparent confirmation of three definite periodicities of approximately 11, 15, and 26 months in solar variation; for the discovery of a new method of measuring the atmospheric ozone and its influence on solar-constant observations; for the repetition of a former investigation of solar and terrestrial absorption lines and bands in the solar spectrum, but with nearly threefold richer results; and for the observation of the distribution of energy in the spectra of 18 stars and two planets.

FISCAL YEAR 1929–30

WORK AT WASHINGTON

Continuous series of solar observations having been made as hitherto at several field stations on desert mountains in distant lands, these observations have been critically studied and prepared for publication at Washington. Several new investigations based on these observations have been made during the year.

The observers in the field at Montezuma, Chile, completely reduce their measurements according to a definitive system adopted several years ago. Telegrams in code arriving daily from Montezuma are decoded and furnished about 24 hours after observing to the United States Weather Bureau, which publishes the solar-constant values on the Washington daily weather map. It is planned to include these results also in a broadcast of miscellaneous geophysical data to begin in July, 1930, under the auspices of Science Service.

The variations of solar radiation seldom range beyond 3 per cent, yet, as will appear below, they seem to produce important weather changes even when as small as 0.5 per cent. It is only at high-altitude stations under very tranquil sky conditions that results of sufficient accuracy to display these small solar variations are to be obtained. Although visibly excellent, our station at Table Mountain, Calif. (longitude 117° 41′ W., latitude 34° 22′ N., altitude 7,500 feet), as yet fails to give results of equal consistency to those of the station of Montezuma. A thorough rereduction of all the Table Mountain observations, 1925 to 1930, has been completed with great labor, during the past fiscal year. But it is disappointing. Fluctuations too evidently produced by the haziness or humidity of the atmosphere still are found occasionally in magnitudes of the order of 2 per cent. Accordingly, a new method of reduction designed to more effectively allow for these atmospheric changes was being developed at the close of the period covered by this report. Preliminary results by it seemed more promising. Reduction of Mount Brukkaros observations is being postponed until the success of this new method is tested for Table Mountain.

Correction for atmospheric ozone.—As stated in last year's report, one troublesome feature of the Table Mountain work has but lately come to light through the studies of Fowle and of Dobson. It appears that a variation of large percentage occurs in the quantity of atmospheric ozone prevailing at very high levels above Table Mountain. Fortunately only about one-fifth as much change of ozone occurs above Montezuma. The change occurring above Table Mountain is sufficient, if uncorrected for, to introduce nearly 1 per cent change in the results on the solar constant of radiation, but the corresponding effect at Montezuma is negligible.

We were not aware of this source of error when the Table Mountain station was first occupied. It was not until several years after the work began that we introduced there Dobson's method of measuring ozone. Hence, if ozone corrections to solar-constant values were to be made from 1925 on, daily, and not merely by averages, as suggested in last year's report, it became necessary to discover a method whereby the correction could be computed from our daily solar-constant observation themselves. This has been done.

Figure 1 [9] shows a portion of the solar energy curve observed at air mass 2.0. The ozone absorption occurs between places 20 and 26 of this curve, but is barely, if at all, visually discernible thereon, even when ozone is most prevalent. However, its effects can be made both discernible and measurable by the following simple procedure. If we take a half dozen of the best days observed in autumn, when the ozone is near its minimum amount, and compute the mean values of the heights of the energy curve in the blue, green, yellow, and red we obtain thereby standard values proportional to the distribution of energy in this region. These standard values, as thus extended from the violet of the spectrum to the red, overlap at each end the ozone region. Next consider the observations of the heights of the energy curve at these selected places on any given day of observation. We divide them by the standard values just referred to and the result is a series of ratios, near unity, but tending sometimes to be lower in the violet than in the red, or vice versa. If plotted against the spectrum place-numbers, these ratios may lie nearly in straight lines. But if the ozone content of the atmosphere on the day examined is different,

[9] Not here shown. See Plates IX and X.

being larger or smaller, than that of the average of the standard days, then the ratio plot just described presents a loop below or above that straight line which is fixed by the unaffected spectrum regions in the violet and the red. These facts are illustrated in Figure 2.[10]

The deviation from the straight-line plots of these energy-spectrum ratios becomes, then, a measure of the ozone contents of the higher atmosphere. The results have been so reduced by us as to give the percentage corrections for ozone absorption to be applied to our solar-constant values on all days of observation at Table Mountain. These corrections apply only to the so-called "short method" of observation. The long method takes cognizance of the ozone absorption in another way.

By the generosity of a friend of the Institution we are preparing to send an expedition to Table Mountain in September, 1930, to make solar observations there through definite known amounts of ozone, so as independently to standardize this new ozone method. The method is applicable on all days when solar-radiation work has ever been done.

Dependence of Weather on Solar Variations.—Obviously the weather depends on the sun. If the sun's emission of radiation varies, then the weather must change in some measure on that account. Having six consecutive years of daily observations of solar variation, made and reduced in the most exact way at Montezuma, the variations have been compared with temperature changes in Washington, Williston, and Yuma.

Figure 3[11] shows the solar-radiation measurements at Montezuma since 1924. Satisfactory, nearly satisfactory, and unsatisfactory observations are indicated thereon by circles, crosses, and points, respectively. In passing, I draw attention to the facts that the results average higher in 1924 and 1925 than in 1929, but return to higher values during the summer of 1930. Also the years 1924, 1926, and 1928 are more affected by long range variations than 1925, 1927, and 1929. This fact tends to verify the 2-year period of solar variation to which I drew attention in last year's report.

What I now particularly note are the numerous cases of sequences of ascending and descending solar-radiation values, occupying about 4 days per sequence. These are indicated by curved full and dotted lines respectively in Figure 3. There are 98 cases of ascending and 91 cases of descending sequences thus indicated. If it had been possible to observe on all days, there would probably have been nearly twice as many such sequences. I have omitted cases where the change was less than 0.4 per cent in the solar-constant value, and also have omitted cases depending on isolated or unsatisfactory values.

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[10] See Figure 20, p. 127.

[11] See Figure 23, p. 246.

Corresponding to each of these 189 cases I have tabulated the mean temperature of Washington, Williston, and Yuma, for a 9-day period, of which the day of culmination of the solar change is the fifth or central day. Taking each month of the year by itself, I have computed the average march of temperature over such 9-day intervals. In illustration, I gave Tables 1 and 2,[12] showing the Washington temperature results of March, and Figure 4, which shows, at A, B, C, and D, the mean values for March, May, July, and October. There is given at E the average changes of solar radiation values corresponding thereto.

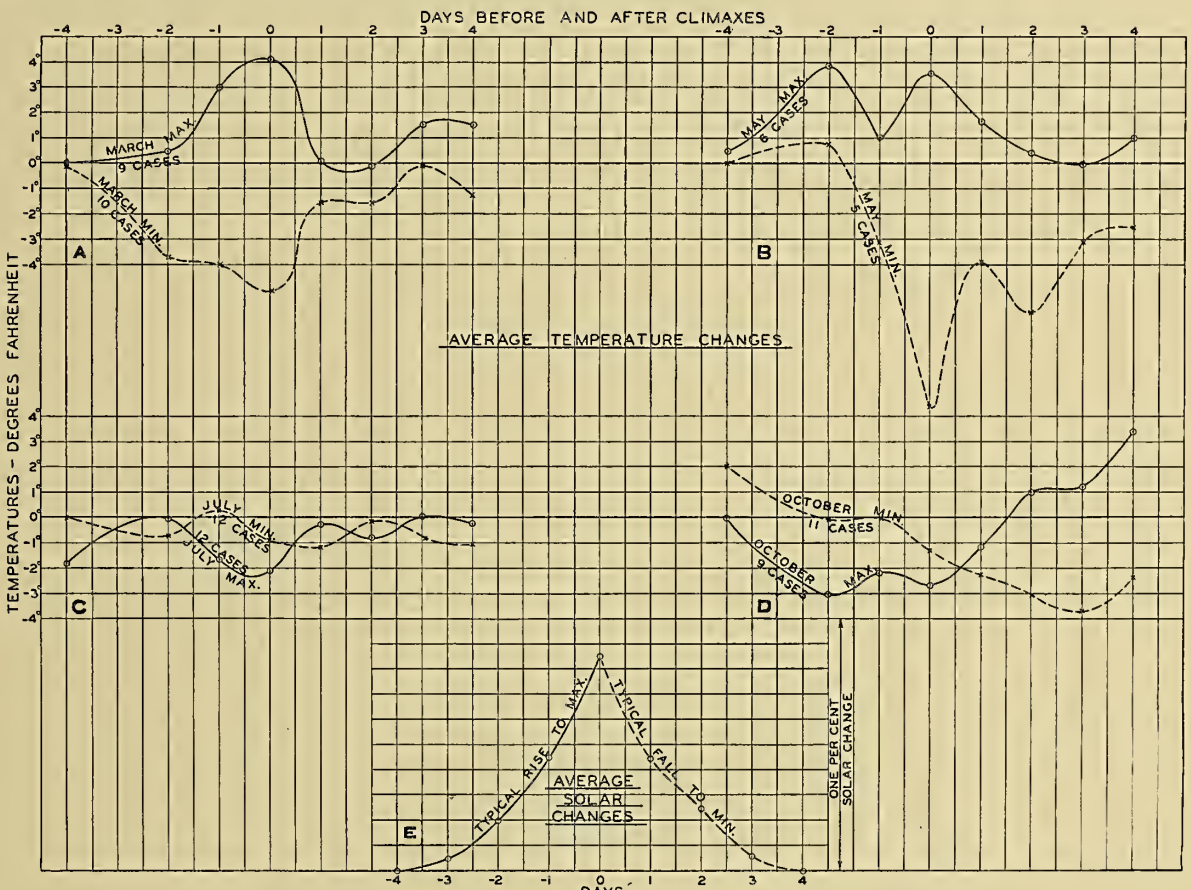


FIGURE 4.—Solar changes and associated temperature changes at Washington

There are several reversals of sign of the average temperature effects during the year. In Figure 5, I give a study of these changes of sign at Washington. All the cases have been arranged in consecutive order of days throughout the year, irrespective of what year they occurred. The 98 cases corresponding to ascending sequences are given in Diagram F, and those corresponding to descending sequences in Diagram G. The quantity which is plotted is the difference of temperature between that of the day of culmination of solar change and that of four days previous. To guide the eye as to the prevailing trend of the results, a zigzag line connects

[12] Not here given. See Tables 43 and 44, pp. 270, 271.

the separate points. The area it includes over the line of zero departures is cross hatched. Obviously the Diagram F has a preponderance of crosshatched area below the zero line, and the Diagram G above. Yet in April, and from June to mid-November, these aspects tend to reverse themselves in each diagram. To bring out this characteristic more plainly, I give in each diagram curves made by taking 5-case consecutive means. That is, the mean is taken of cases 1 to 5, 2 to 7, 3 to 8, and so on. As it seemed clear that such a curve in Diagram G is nearly

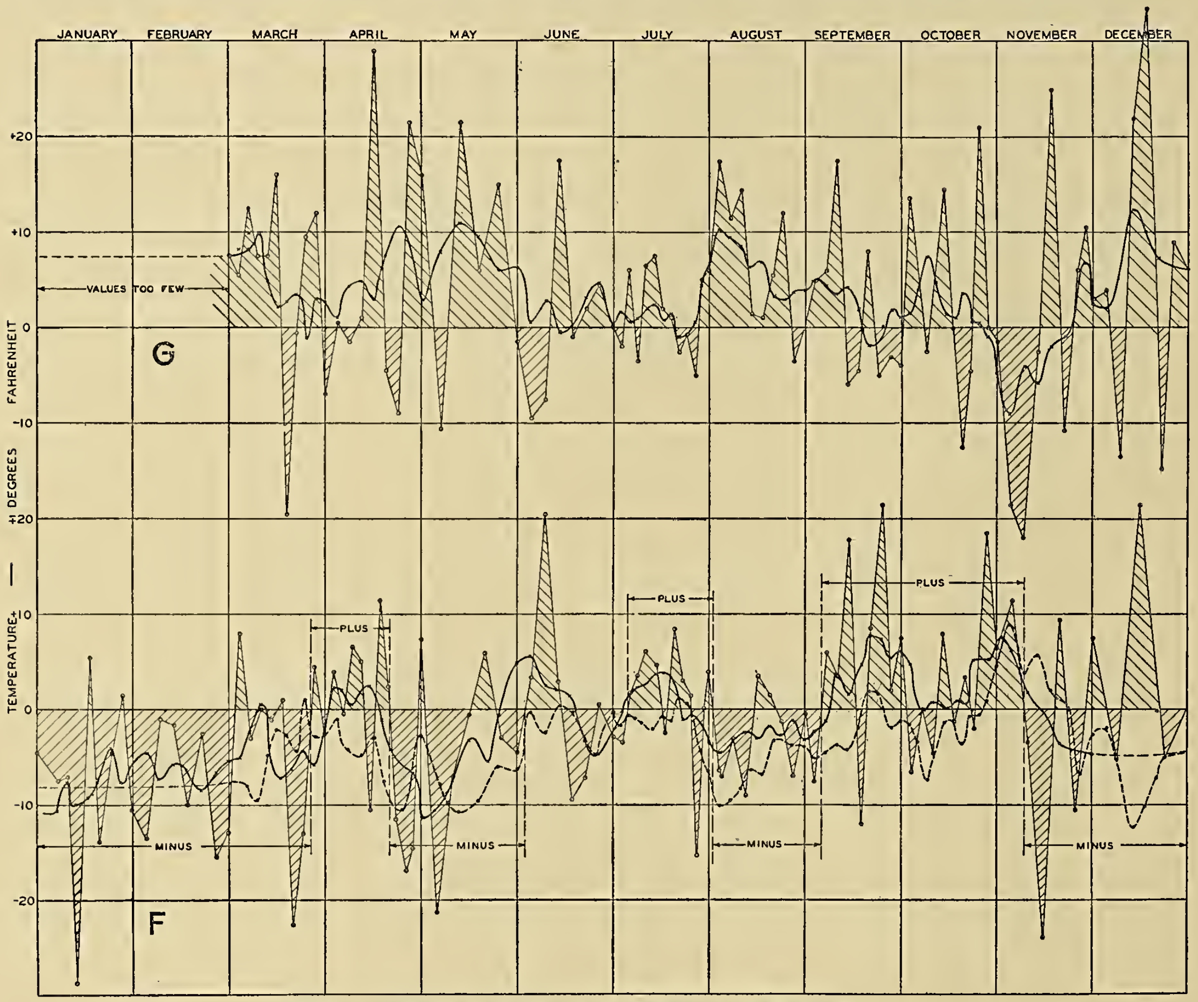


FIGURE 5.—Inversions of temperature dependence on solar variations

the reverse of that in Diagram F, I have inverted the 5-day mean curve of G as the dotted curve in F. The correlation coefficient between the full and dotted curves in F is 50 ± 5 per cent.

Results are found for Yuma and Williston similar to those presented for Washington. Though the types of effect do not occur in identical months at the three stations, the magnitudes and tendencies are much the same.

From all this I conclude:

1. An apparent influence of short-period solar variation appears in the temperature of the United States.

2. Corresponding to 0.8 per cent change in the sun, there appear to be temperature changes of the order of 5° F. at Washington.

3. The sign of the correlation changes during the year.

4. A high negative correlation is found between the temperature effects corresponding respectively to rising and to falling sequences.

5. The temperature effects coincide in date with the solar changes which appear to induce them.

6. If the connection between solar change and temperature change is a genuine one, it must operate by some indirect atmospheric mechanism; because if it were a direct effect its sign would not change during the year.

7. Although complicated, the relation seems to offer promise for weather forecasting nearly a week in advance. Yet the occasional inversions of effect found inspire caution in a pronouncement of this character. These apparent inversions are, however, doubtless caused frequently by one solar change treading too quickly on the heels of another. Again, they may sometimes be caused by delayed receipt from distant centers of action of waves of temperature effect arising from former solar changes.

The results thus far are tentative. It is proposed to study barometric pressures as well as temperatures and to extend the investigation to other parts of the United States and of the world. Preliminary studies have been made, too, of 10-day mean values of solar radiation and temperature, and we hope that in this way, if reliable weather-forecasting data are really secured, they may be extended to months and seasons in advance.

FIELD STATIONS

Observations of the solar radiation have been continued whenever weather conditions would permit at Table Mountain, Calif., at Mount Montezuma, Chile, and at Mount Brukkaros, Southwest Africa. All three stations continue to report measurements as made on three-quarters of the days of the year or more. However, not all of these observations prove satisfactory, so that 60 per cent is a better estimate of available observation days for these selected high-level desert stations.

A strange and serious accident occurred in December on Mount Brukkaros. It will be recalled that for the sake of uniformity of temperature conditions our observatories are in the form either of tunnels in solid rock or cemented chambers underground. In a hard thundershower on January 24, 1930, the interior of the tunnel in the mountain face was struck by lightning, and the bolometer, the resistance box, and other parts of the electric circuit were burned out. Fortunately a second bolometer and some other spare parts were in stock, so that the observer, Mr. Sordahl, by diligence and clever adaptations, was able to restore the circuits so as to recommence observing with the loss of only four days.

Mrs. Sordahl is keeping an interesting daily journal of events, and, having zoological training, is also making a valuable collection of the fauna and flora of the Mount Brukkaros region for the United States National Museum.

PERSONNEL

At Washington, Dr. C. G. Abbot continues as director. Finding himself unable to give sufficiently continuous attention to the work, he appointed Mr. L. B. Aldrich to be assistant director, beginning May 19, 1930; F. E. Fowle, research assistant; W. H. Hoover, associate research assistant (detailed to the Division of Radiation and Organisms); Mr. A. Kramer, instrument maker; Mrs. A. M. Bond, statistical assistant, reinstated October 16, 1929, vice Miss M. Marsden, resigned October 10, 1929; Mrs. M. D. (Denoyer) Johnson, computer; Mr. W. Oliver Grant, assistant computer.

In the field: Mr. A. F. Moore, field director, Table Mountain, Calif.; Mr. F. A. Greeley, bolometric assistant, Table Mountain, Calif.; Mr. H. H. Zodtner, field director, Montezuma, Chile; Mr. C. P. Butler, bolometric assistant, Montezuma, Chile; Mr. L. O. Sordahl, field director, Mount Brukkaros, Southwest Africa; Mr. A. G. Froiland, bolometric assistant, Mount Brukkaros, Southwest Africa.

SUMMARY

This year has been notable for both disappointment and achievement. Disappointment—because the high hopes of satisfactory accuracy raised by preliminary results of reduction of observations at Table Mountain proved to some extent illusory and have given place to tests of new methods designed to remove more effectually atmospheric sources of error. Achievement—in the invention of a new method of determining the amount of atmospheric ozone, applicable on every day in which solar radiation observations have been made; in the discovery of the apparently large and exceptionally important influence exercised by small short-interval solar variations on terrestrial temperatures; and for the continuation under favorable auspices of observing at the station on Mount Brukkaros, Southwest Africa.

Chapter II

STATIONS AND INSTRUMENTS

THE CAVE FORM OF OBSERVATORY

Although the sun furnishes about a horsepower of energy per square yard of normally exposed surface of the earth, nevertheless we can not use coarse and rough instruments in this research. On the contrary, the bolometer, which records changes of temperature of the order of a millionth of a degree, is none too sensitive. Its use demands good control of surrounding temperatures.

Since 1915 the temperature conditions immediately surrounding the sensitive strips have been stabilized by using the bolometer in vacuo. As the temperatures of the sensitive strips are raised by the electric current through more than 50° C. above their immediate surroundings, whether used in air or in vacuo, it is apparent that the removal of the eddying air from around the strips tends to reduce greatly their accidental temperature changes. It also increases fully fivefold their rise of temperature due to absorbed radiation, so that a double gain results from evacuation of the bolometer case. It is a disadvantage that the rays must pass through a window. We shall discuss this below.

For the control of general temperature conditions, Mr. E. B. Moore of Los Angeles, brother of Mr. A. F. Moore, director at Table Mountain, made the valuable suggestion in 1919 that the observatories should be located in tunnels underground. This form we adopted in 1920, when the stations at Montezuma and Mount Harqua Hala were established. We have retained it in the establishments at Table Mountain, Calif., and Mount Brukkaros, Southwest Africa. We have found it satisfactory excepting that in Southwest Africa and in Chile we have been troubled sometimes in winter by electric charges collecting within the caves.

In the sloping face of a mountain summit, a horizontal tunnel about 10 feet wide, 7 feet high, and 35 feet deep is either drilled or excavated and heavily roofed over with soil. In the Northern Hemisphere, this tunnel occupies a place on a mountain slope of southern exposure. In the Southern Hemisphere, a northern slope is chosen. The bolometer, the spectrometer, and the galvanometer, for all of which the uniformity of temperature during a morning's observational run of several hours is desirable, are located near the rear of the tunnel. There neither sun nor wind can play upon them, and the deep-lying earth or rock above and around them fluctuates little in temperature throughout the year. A coelostat

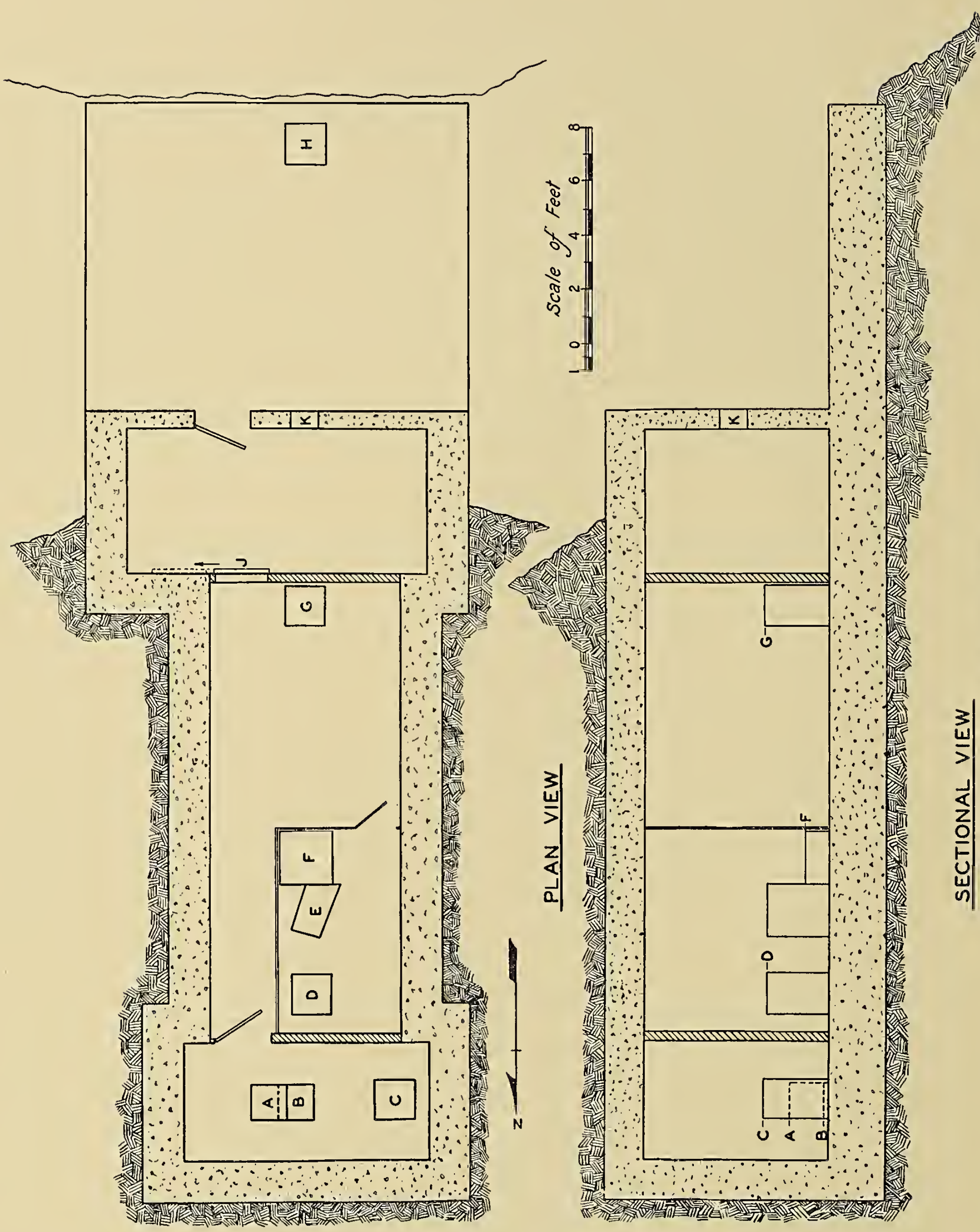


Figure 6.—Table Mountain Station. Diagram.

located outside the tunnel's entrance reflects a suitable beam of sunlight into the tunnel in a north and south direction. The arrangement of affairs at Table Mountain is indicated in Figure 6.

Far more important than the temperature conditions surrounding the apparatus are the conditions of the atmosphere through which the solar rays come to be measured. The longer our experience the more we are impressed by the fact that nowhere in the world are the atmospheric conditions good enough to fully satisfy the exacting demands of the study of solar variation.

Consider the smallness of the variations to be measured and the difficulty of measuring them. In our early work at Washington, Mount Wilson, and Bassour, as published in Volumes II, III, and IV of these Annals, the range of solar variation which seemed to be fairly evidenced reached about 10 per cent. We think now that more than half of this range was due to terrestrial causes, not solar. In the more recent work now to be reported, the extreme range is not above 4 per cent. A considerable part of this range comprises well-supported cycles of solar change covering several months or years. The short-interval solar variations which, superposed upon this slower march tend to swell the extreme range of solar variation within the past 10 years to 4 per cent, are limited to quantities which only seldom exceed 1.5 per cent. The larger short-interval variations often follow by about one day the central passage of a great sun spot.

In variable-star work comparison stars are available. The observations may be made differentially, and thus with almost complete elimination of atmospheric sources of error. Yet measurements of stellar variations of the order of less than 1 per cent, corresponding to 0.011 stellar magnitude, would be somewhat difficult. Much more difficult must be the investigation of solar variation where the absolute intensity of solar radiation of one day is to be compared with the absolute intensity of another in order to yield by difference the change of intensity sought. On each day, moreover, the earth's atmosphere, with its changing load of dust, water vapor, clouds, and ozone, lies in the path of the rays before they reach the measuring station, and greatly enhances the difficulty of the determinations.

REMOVALS: MOUNT WILSON, MOUNT HARQUA HALA, TABLE MOUNTAIN, MONTEZUMA

These considerations enlisted the deeply solicitous attention of Mr. John A. Roebling in 1920, when he generously supplied means to remove the solar-constant observatory from Mount Wilson to the best site to be found in the southwestern United States. He gave means, at the same time, to remove the Calama station to a higher situation on Mount Montezuma, more remote from the contaminating atmospheric influences of towns and mining operations. Still solicitous to assist in selecting the best sites, he provided means in 1930 to test for a full year the advantages of the highest mountain peaks in Southwest Africa and elsewhere.

An account of the removals has been given in Chapter I, which rehearses the annals of the work. Suffice it here to say that after studies of a number of proposed sites in California and Arizona, at which special observations devised to record the clearness of the sky were conducted for us by the kindness of the Chief of the United States Weather Bureau, Mount Harqua Hala (lat. 33° 48′ N., long. 113° 20′ W., alt. 5,646 ft. = 1,721 m) was chosen.

A building partly underground was constructed there in the summer of 1920 by Messrs. Banks and Lucas of Wenden, Ariz. Adobe bricks, made on the mountain summit, were used in constructing the walls. After a year of occupancy, the building was sheathed with galvanized iron to prevent its destruction by rains. It was first occupied by Messrs. Abbot and Aldrich in September, 1920, and remained in use as an observing station until November, 1925.

Plate I shows the Mount Harqua Hala Observatory in its earlier and later conditions.

Although during a considerable part of the year Mount Harqua Hala proved a fairly suitable site for the work, the summer months, especially July and August and part of September, proved almost worthless there. Extreme haziness, rapid change of atmospheric transparency, high winds, and, occasionally, tremendous electrical storms rendered the conditions in these months so bad that the observations were hardly worth making.

DATA OF LOCATIONS AND CONDITIONS

TABLE MOUNTAIN

In 1925 Mr. Roebling, solicitous that our stations should enjoy the most favorable conditions, furnished the means to remove this observatory and reestablish it on Table Mountain, Calif. (lat. 34° 22′ N., long. 117° 41′ W., alt. 7,500 ft. = 2,286 m).

Before locating there, Mr. A. F. Moore made several visits to Table Mountain at different times of the year. Special reports as to cloudiness were also obtained. According to the experience of subsequent years, during which Mr. Moore has kept records from the point of view of the solar observer, the average conditions are as follows:

Table 1.—*Average conditions for observing at Table Mountain*

Month	Temperature [1]		Wind		Solar constant, number of days observed
	Maximum	Minimum	Direction [2]	Velocity [3]	
January	42. 0	25. 7	S. W.	8. 8	19
February	43. 0	27. 7	S. W.	8. 1	18
March	46. 0	29. 4	S. W.	8. 2	21
April	52. 7	33. 9	S. W.	8. 8	24
May	61. 1	40. 2	S. W.	7. 7	27
June	72. 5	50. 8	S. W.	6. 9	28
July	77. 9	57. 0	S. W.	6. 3	29
August	77. 0	55. 8	S. W.	5. 8	29
September	69. 9	49. 0	S. W.	6. 9	[4] 28
October	61. 0	42. 5	S. W.	5. 4	29
November	52. 4	35. 5	S. W.	4. 7	24
December	42. 1	27. 2	S. W.	6. 7	22
Yearly average of days observed					298
Total number, December, 1925, to December, 1930, inclusive					1, 512

[1] Averages of mean maximum and mean minimum temperatures for respective months, using means of 5 years for all months except October, November, and December, where 4 years were used.

[2] Means of prevailing wind directions. In the prevailing direction for individual months, N. E. occurred in January, February, March, October, November, and December, and N.W. in April, but S.W. occurred in the majority of years for every month.

[3] Wind velocity mean of only 2 years, since Mount Wilson anemometer was set up at Table Mountain. The means are gotten by taking the total mileage traveled (mean for eaeh month) and dividing by 24 to get hourly average. The 2-year means are then averaged to get values given above.

[4] In September, 1928, on 5 cloudless days forest-fire smoke prevented observing. The above value of 28 days counts this the same as cloudy days. Otherwise the average would be 29 days for September and 299 for the year.

In the year 1928 the California Institute of Technology became interested in the astronomical seeing on Table Mountain as compared with other stations. Our observers cooperated in these tests. The following comparative table of seeing is as estimated on a scale of 10 by observers trained to the same method, equipped with similar observing instruments, and intercompared so as to eliminate personal equation.

Table 2.—*Comparison of astronomical seeing at Mount Wilson and Table Mountain, Calif., August 1, 1928, to April 7, 1930*

	Total number nights	Percentage nights having seeing—					
		0–1	1–2	2–3	3–4	4–5	5 and over
Mount Wilson:							
Aug. 1, 1928–Nov. 1, 1928	86	2	15	25	26	23	9
Nov. 1, 1928–May 1, 1929	126	18	23	31	18	5	5
May 1, 1929–Nov. 1, 1929	173	5	13	23	33	16	10
Nov. 1, 1929–Apr. 7, 1930	121	17	22	28	22	4	7
Table Mountain:							
Aug. 1, 1928–Nov. 1, 1928	84	0	0	12	11	21	56
Nov. 1, 1928–May 1, 1929	151	7	5	11	18	21	37
May 1, 1929–Nov. 1, 1929	180	2	4	5	13	22	54
Nov. 1, 1929–Apr. 1, 1930	137	2	3	10	19	19	47

From what has been said, the reader will be apt to conclude that Table Mountain is an ideal site. The accompanying table and illustration (fig. 7) will somewhat qualify this impression The period including the months February, March, April, May, and June is far inferior to the remainder of the year because of excessive haziness. This injures decidedly the value of the results during this period. Taking all things into consideration, however, it seems doubtful if a more favorable site could be found in the United States.

Plates II and III give an idea of the station and its setting.

TABLE 3.—*Brightness of the sky near the sun. Mean pyranometry values. Table Mountain, December, 1925, to August, 1927*

Month	Number of days	Limits of precipitable water	Mean pyranometry	Month	Number of days	Limits of precipitable water	Mean pyranometry
		Mm	*Calories*			*Mm*	*Calories*
January	18	0–4	0.0167	July	6	0–4	0.0169
	8	4–7	165		15	4–7	183
February	11	0–4	192	August	7	0–4	169
	4	4–7	206		1	4–7	167
March	2	0–4	198	September	11	0–4	175
	9	4–7	250		------	4–7	----------
April	2	0–4	240	October	7	0–4	174
	9	4–7	249		10	4–7	178
May	18	0–4	295	November	1	0–4	190
	11	4–7	356		8	4–7	173
June	8	0–4	235	December	12	0–4	168
	8	4–7	287		8	4–7	162

MONTEZUMA

This site was selected by Mr. A. F. Moore while he was still directing the field work in Chile. It lies nearly south and about 12 miles from Calama (lat. 22° 40′ S., long. 68° 56′ W., alt. 8,895 ft. = 2,711 m). Mr. Moore superintended the construction of the road to the site, the tunnel and piers for apparatus, the dwelling for observers, and the outbuildings, and transferred the instruments from Calama to Montezuma. The removal was so well planned and so diligently accomplished by Mr. Moore that only 10 days of observing were lost.

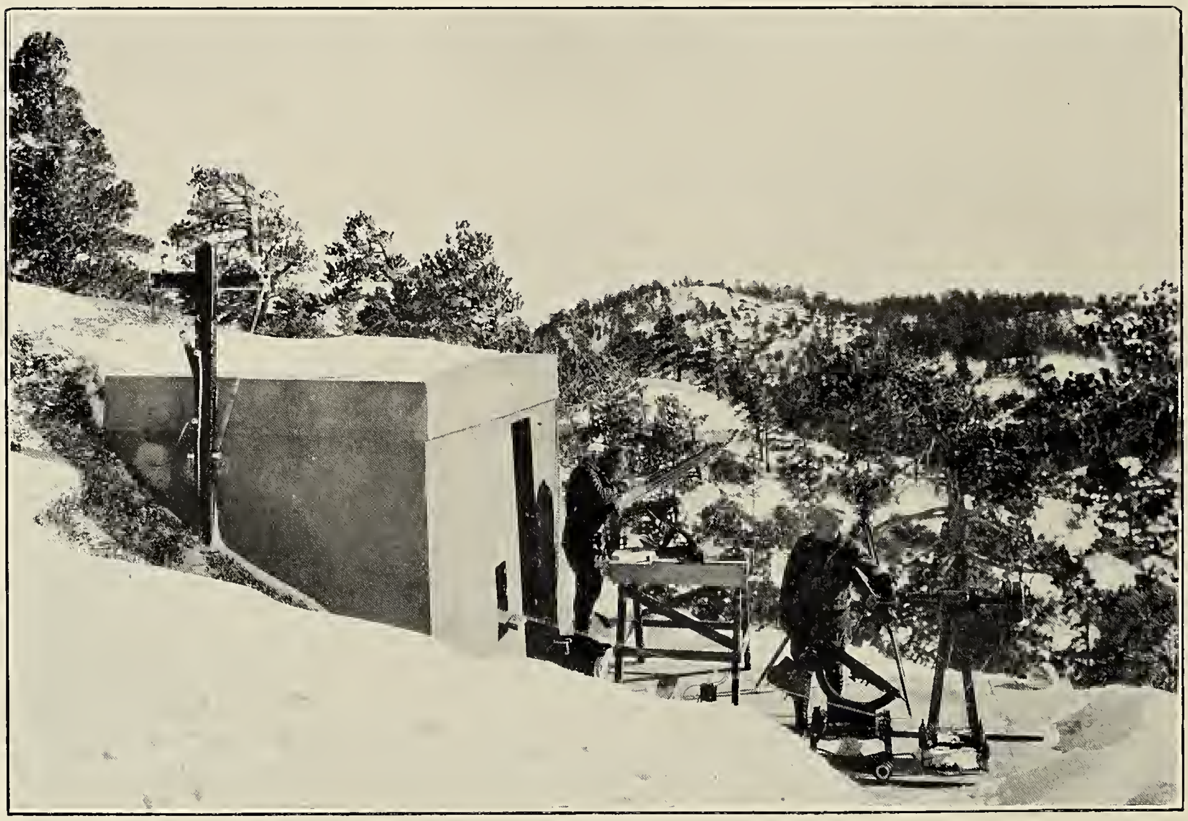
The following table and Figure 8 give data regarding the conditions for observing at Montezuma. It is apparent that the cloudlessness of the site and the uniformity of sky conditions there reached a high standard.

1

2

Mount Harqua Hala Observatory and Surroundings

1



2

Table Mountain Observatory

1

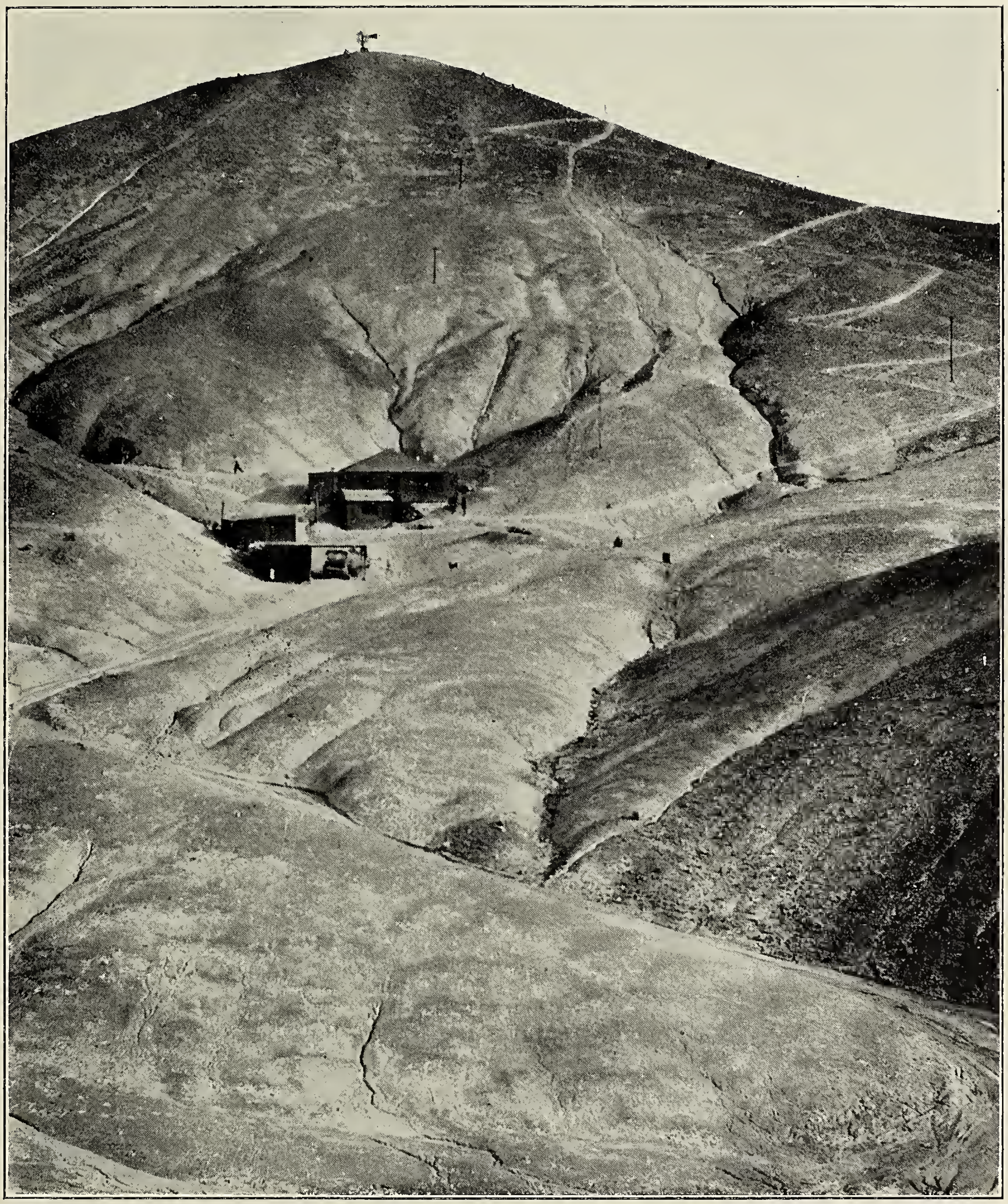
2

Table Mountain Station and Surroundings

1

2

1. Montezuma Observatory. 2. Brukkaros Observatory



MONTEZUMA STATION AND SURROUNDINGS

1

2

Brukkaros Station and Surroundings

Table 4.—*Mean monthly observing conditions, Montezuma*

	Number of days observed				8 a. m., temperature Farenheit	Air mass 2.0	
	Clouds			Total observed		Precipitable water	Pyranometry
	Prevent	Circumscribe	Few				
January:					°	*Mm*	*Calories*
1929	12	7	[1] 6	13	56. 4	12. 7	0. 0240
1930	14	11	6	17	60. 9	13. 2	228
February:							
1929	9	4	15	19	58. 5	17. 2	257
1930	7	8	13	21	57. 5	10. 3	249
March:							
1929	6	5	20	25	59. 0	10. 9	208
1930	3	2	26	28	59. 2	9. 0	199
April:							
1929	0	1	29	30	56. 7	3. 6	146
1930	1	4	25	29	57. 0	4. 9	157
May:							
1929	6	1	24	25	51. 4	4. 5	139
1930	10	1	20	21	53. 4	4. 1	135
June							
1929	10	2	18	20	46. 8	4. 8	127
1930	3	1	26	27	50. 7	[2] 2. 5	131
July:							
1929	2	1	28	29	48. 6	3. 5	135
1930	1	5	25	30	49. 2	2. 8	123
August:							
1929	5	1	25	26	47. 3	3. 0	142
1930	8	2	21	23	48. 8	3. 3	142
September:							
1929	2	1	27	28	53. 9	3. 0	160
1930	7	4	19	23	57. 2	4. 5	164
October:							
1929	9	4	[3] 17	21	56. 4	3. 6	172
1930	4	3	24	27	57. 4	3. 6	158
November:							
1929	3	4	23	27	62. 4	2. 9	183
1930	5	4	21	25	60. 8	5. 1	198
December:							
1929	4	9	18	27	62. 0	5. 0	207
1930	5	7	19	26	62. 8	4. 4	175

[1] Repairs occupied 6 days.
[2] June 16 to 22, 1930, the precipitable water value did not exceed 0.95 mm. June 19, only 0.35 mm. But June 28 showed the absolute minimum, only 0.13 mm.
[3] Earthquake spoiled 1 day.

Plates IV and V give views of the station and surroundings.

MOUNT BRUKKAROS

In order to cover more thoroughly all the days of the year, and to get independent evidence from another locality as to the sun's variation, it seemed very desirable to establish in another part of the world another station cooperating with those at Table Mountain and Montezuma. As the Smithsonian Institution had not the means available, the project was brought to the attention of the officers of the National Geographic Society. After consideration, an allotment of $55,000 was made to Dr. C. G. Abbot on March 20, 1925, to enable him to select a site in the Eastern Hemisphere most promising for the work, to erect and equip there

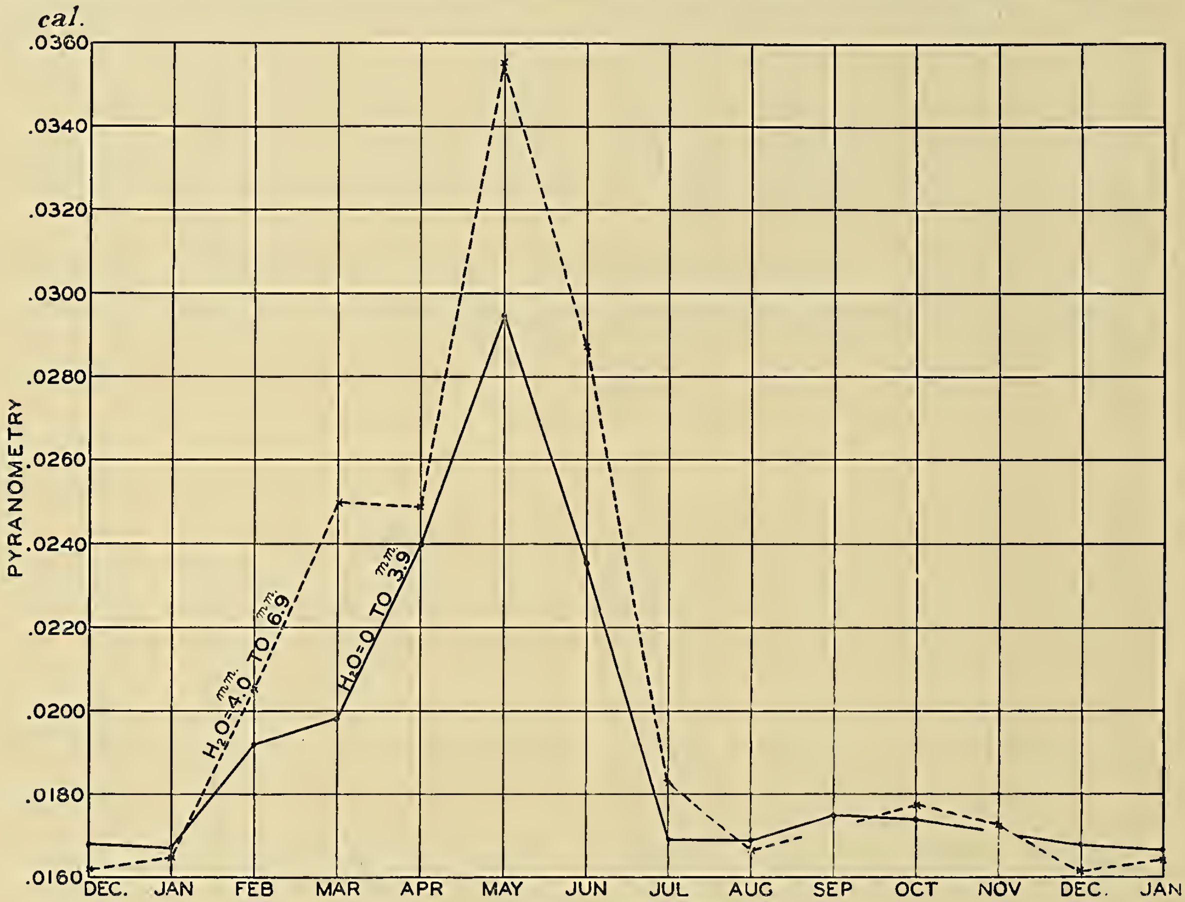


FIGURE 7.—Table Mountain pyranometry

the necessary outfit, and to organize and conduct there, for a period of four years, a solar-radiation observatory cooperating with those of the Smithsonian Institution.

The work requires a high-level, cloudless site, situated accessibly and in a region safe from attack by men and beasts. Freedom from dust and haze, as well as from high winds and dangerous storms, is also highly desirable. High latitudes are to be avoided, in order that the air mass may not be too large for accurate extrapolations during winter months.

On examining Bartholemew's meteorological atlas with these desiderata in mind, attention was fixed on Algeria, Egypt, and Baluchistan, as best representing cloudless subtropical regions of the Northern Hemisphere, and on Southwest Africa and Australia as best representing the Southern Hemisphere. Australia, however, presents no high mountains in the cloudless parts, so that attention was concentrated on the four countries first mentioned.

In Algeria the Jebel Mektar, a little south of Ain Sefra, was ascended, but the records of cloudiness available, very kindly placed at Doctor Abbot's disposal by

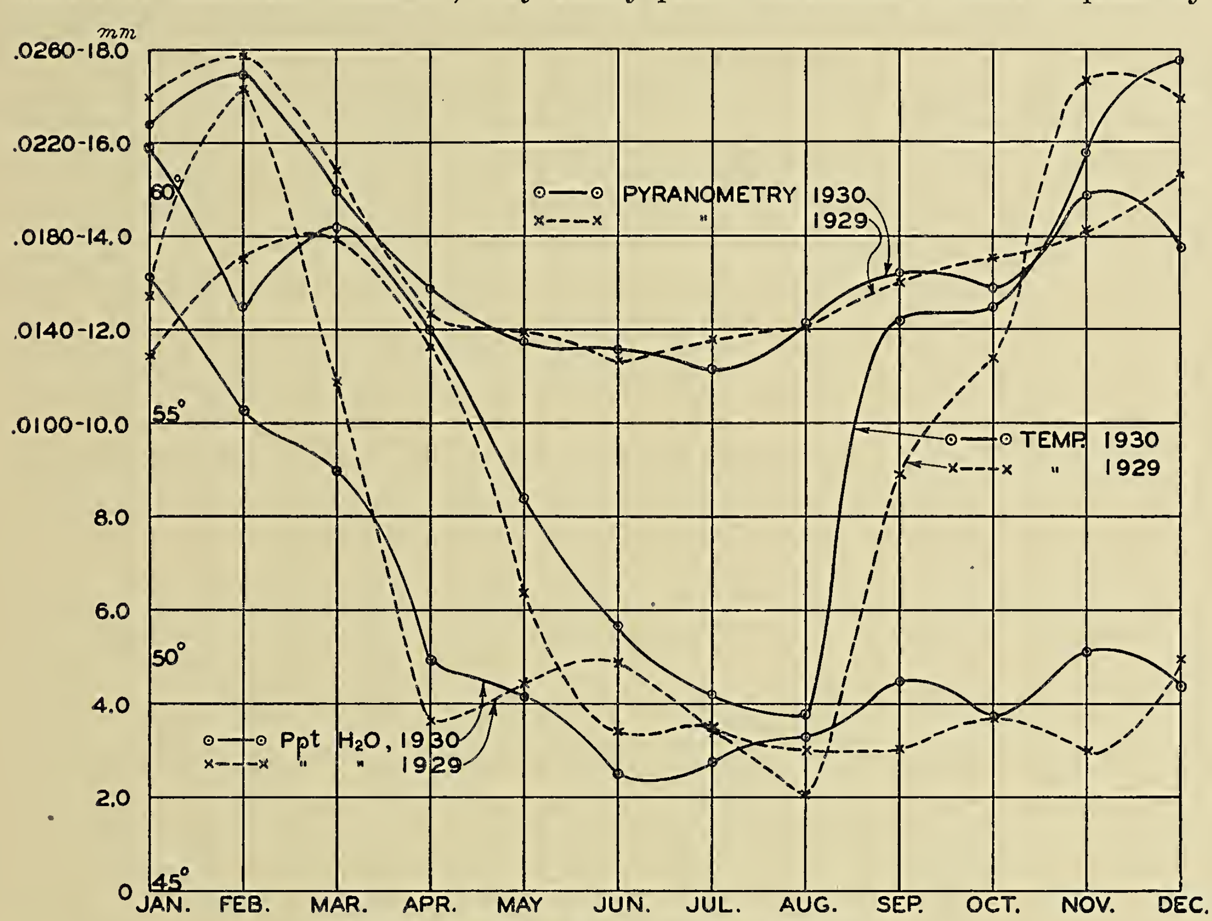


FIGURE 8.—Monthly mean observing conditions at Montezuma

the military officers, did not justify the hope that conditions better than those of Arizona would be experienced. As our hopes contemplated conditions equal to those of Montezuma in Chile, Algeria was definitely abandoned.

In Egypt a few high mountain sites are available. Dr. John Ball, director of desert surveys, indeed, informed Doctor Abbot that in the course of a survey he had reached a mountain on the borders of the Sudan where he presumed that rain never falls. But as he had approached this site by tractor for 200 miles, and had carried all the water required, it seemed out of the question by reason of danger and inaccessibility, however suitable meteorologically. The Mount Sinai region, east of the Red Sea, was seriously proposed. No exact information about its advantages from our point of view was available in Cairo, and the mountain was not at that time easily accessible. Possibly too hastily, that locality was therefore given up.

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After returning to America, information was received from a gentleman who had spent some time about Mount Sinai, which indicates that both as to accessibility and as to cloudlessness its advantages had been underrated. Were the expedition to be undertaken again, more careful consideration of the region of Mount Sinai would be given. Yet the reports of travelers indicate that considerable danger from human invaders would threaten there.

The authorities of the Government of India gave every facility for the study of the availability of sites for the observing station in Baluchistan. Thanks are due especially to Col. Chenevix Trench and to Colonel Barker, both of whom exerted themselves to assist in the actual inspection of sites in that country. Owing to the insecurity of life among the natives of Baluchistan, only a few localities were regarded as suitable for the station. In the immediate neighborhood of Quetta various meteorological circumstances seemed unfavorable. At length, the Khojak Peak, 7,500 feet high, near the pass of that name, 10 miles from the border of Afghanistan, was selected as most suitable. Yet we were informed that it would be necessary to employ soldiers to guard the observatory, and that the observers must lodge at a fort 3 miles distant, traveling daily back and forth with a guard. These and other circumstances seemed to militate against the place for permanent occupation, although from a meteorological standpoint it promised well.

Leaving with Colonel Barker the necessary plans and specifications for construction on Khojak Peak, should no better site be found, the expedition continued on to Southwest Africa. Tentatively, a site near Aus had been proposed. While in Johannesburg, Doctor Reuning recommended for consideration an isolated peak called Spitzkopje a good way to the northeast of Walfish Bay. Arrived at Windhoek, a consultation with officials and meteorologists seemed to indicate that better than either of these places would be Mount Brukkaros (lat. 25° 52′ S., long. 17° 48′ E., alt. 5,202 ft. = 1,586 m), 60 miles northwest of Keetmanshoop. By telegraph, Mr. A. Dryden, inspector of public works, with headquarters at Keetmanshoop, was advised of our coming.

The mountain has the appearance of a volcanic crater with a deep central cup, approachable by a long ravine from the southwest. It stands far isolated from all other mountains, and rises about 2,000 feet above the general level of the plain. The annual rainfall averages only about 3 inches, and though the plain is sparsely grass-covered so that animals abound, trees and shrubs are nearly absent. During a stay of 12 days in the vicinity, though in March and near the height of the rainy season, all of these days would have afforded opportunity for solar-constant observations. The mountain stands within a Hottentot reservation, whose principal town, Berseba, lies about 7 miles distant. These people are peaceable, so that no guards would be required. Transportation to and from Keetmanshoop (60 miles) is easy, except for the Great Fish River bed, sometimes flooded and always sandy, and except for the ascent of the mountain itself. Keetmanshoop is a division point on the railway, which extends from Cape Town to Windhoek and Walfish Bay.

It is impossible, as our experience now shows, to tell in advance and without actual occupation whether a site will be satisfactory meteorologically for solar-radiation observing.

The cloudlessness, isolation, height above all surroundings, official meteorological reports, and other testimony of residents of the neighborhood all tended to indicate that Mount Brukkaros would prove a good site. Moreover, the similarity of its conditions to those in Chile which have made Mount Montezuma so exceptionally favorable seemed entitled to weight. These conditions of similarity are manifold. In both countries the situation is near the edge of the southern tropics and near the west coasts respectively of the similar continents Africa and South America. Both countries are subject to the influences of great antarctic ocean currents just offshore. Each coast opposite the respective sites experiences zero rainfall and considerable fog. In two respects the similarity fails. Mount Brukkaros has no high mountain chain like the Andes in sight, but only the comparatively low chain east of the railway. Mount Brukkaros, moreover, lacks nearly 4,000 feet of the altitude of Mount Montezuma. This last is a great difference, and, as experience proves, is a very serious disadvantage. For the winds are found to carry dust above Mount Brukkaros, which, mingling with the atmospheric humidity prevailing so much more plentifully at this lower altitude than at Montezuma, creates highly prejudicial haze during no inconsiderable part of the year.

Though we regretted that Mount Brukkaros is no higher, yet it seemed to have so many and so great advantages, and seemed to offer so favorable promise from a meteorological standpoint, that it was selected as the site for the solar-radiation observatory of the National Geographic Society. With the cordial cooperation of the Government of Southwest Africa, Mr. Dryden was directed to excavate the necessary tunnel on a chosen site near the summit of the western rim, to prepare piers, a reservoir, and a dwelling for observers, and to improve the means of access to the site chosen. These improvements were to be made at cost. All of this Mr. Dryden did with excellent judgment and assiduity, so that the observatory, which was definitely planned in May, 1926, was ready for occupancy in September, and actual observing was begun in December of that same year. The aid of the Southwest African Government had meanwhile gone still further, in the erection of a telephone line connecting with the railroad line 30 miles away.

Plates IV, Figure 2, and VI show the observatory, the dwelling, and some scenes typical of Mount Brukkaros.

In the following table, meteorological conditions of Mount Brukkaros are shown in their relations to solar-radiation work. It is apparent that the station falls short of Montezuma in suitability, and is in some respects less satisfactory than

Table Mountain. Only experience could prove this. As stated above, Mr. Roebling has lately promoted a comparison of Mount Brukkaros as a solar-constant station with several higher peaks of Southwest Africa and elsewhere. Results of this study are not yet available.

TABLE 5.—*Mean monthly observing conditions, Mount Brukkaros*

	Number of days observed				8 a. m., temperature,[1] Centigrade	Air mass 2.0	
	Clouds			Total observed		Precipitable water	Pyranometry
	Prevent	Circumscribe	Few				
January:					°	*Mm*	*Calories*
1929	9	5	14	19	22. 1	15. 3	0. 0372
1930	8	5	18	23	19. 5	18. 1	283
February:							
1929	11	6	11	17	20. 8	13. 8	315
1930	6	13	9	22	20. 3	14. 1	264
March:							
1929	14	3	14	17	19. 3	15. 8	227
1930	5	5	21	26	19. 2	17. 6	218
April:							
1929	13	0	17	17	16. 8	10. 6	192
1930	3	0	27	27	18. 1	12. 9	196
May:							
1929	17	0	14	14	16. 1	9. 9	203
1930	2	7	22	29	15. 8	7. 6	188
June:							
1929	14	0	16	16	12. 3	6. 7	203
1930	5	3	22	25	12. 7	6. 4	198
July:							
1929	12	0	19	19	10. 0	5. 1	227
1930	6	1	24	25	12. 5	6. 8	249
August:							
1929	18	2	11	13	--------	6. 7	265
1930	8	4	19	23	11. 3	6. 0	255
September:							
1929	13	4	13	17	18. 6	7. 7	246
1930	7	4	19	23	12. 2	5. 3	236
October:							
1929	12	2	17	19	17. 8	11. 1	261
1930	8	6	17	23	17. 6	8. 4	257
November:							
1929	14	9	7	16	20. 3	12. 2	257
1930	6	5	19	24	18. 5	12. 2	326
December:							
1929	12	6	13	19	19. 5	14. 1	269
1930	4	6	21	27	20. 2	11. 2	286

[1] These temperatures are right for 1929 from January to July. Those headed 1929 from September to December are of 1927. Those headed 1930 are all of 1928. All are from the dry bulb of the psychrometer. These observations were immediately available, and being as well suited to show the march of temperatures of the stations, were preferred to those of the latter part of 1929 and 1930, which were not immediately available.

OTHER STATIONS

La Quiaca.—At the request of the Argentine Government, the Smithsonian Institution prepared at cost a solar-radiation outfit, trained a director (Mr. W. H. Hoover) to use it effectively, and superintended to some degree the establishment of a solar-observing station at the Meteorological Observatory of La Quiaca, Argentina, near the boundary of Bolivia. The location, though at great altitude and convenient to the railway, is not ideal, for it lies on a very extensive, nearly level plateau, near the town, and is subject to dust and smoke as interference with the sun rays. Although regular observations were maintained there through a part of each year from the establishment of the station in 1924 until 1930, the methods employed did not keep pace with improvements introduced at other stations, and less and less interest was taken in the work by the Argentine authorities.

Sydney.—The late Rev. E. F. Pigot, of Riverview College, Sydney, Australia, became greatly interested in the Smithsonian radiation work, and raised funds sufficient to purchase a complete solar-radiation outfit from the Smithsonian at cost in the year 1922. Mr. A. F. Moore installed it at the college, but unfortunately the coelostat had been set so far from the observing room that the beam was too much weakened by the spreading corresponding to the sun's diameter to give proper deflections in the spectrum. Not recognizing the cause of the trouble, the bolometer was returned to America as insensitive, but was found all right and sent back. Dampness from the oceanic climate meanwhile had helped mould to grow about the galvanometer needle, and this was spoiled in attempting to repair it. Doctor Pigot having also suffered a severe accident, the apparatus was never put in order for observing.

At the time when this project was formed, we did not fully realize the exacting nature of the observations, and the necessity of a dry and elevated site to secure results competing in accuracy with those required to demonstrate solar variability. It is a very great pity that so much enthusiasm and sacrifice should have yielded such disappointing returns. Had nature furnished a high mountain in central or western Australia, there is no region on earth where a solar-radiation observatory would be more favorably located.

INSTRUMENTS OF RESEARCH

BOLOMETER

In Volume IV of these Annals, pages 45 to 65, we developed the theory of the vacuum bolometer, and illustrated the instrument as employed after the year 1915 at our field stations. For several years we have made use of an improved form of glass container which the Bureau of Standards has very kindly assisted us to introduce. This container is now made as shown in Figure 9. Its side tubes, t, t', end in optically figured plates which are sealed hermetically to the ends of these tubes by the process developed at the Bureau of Standards. In this way the spectral definition is improved over that which the old form permitted, and stray light is reduced.

The Philosophical Magazine for June, 1929 (Supplementary Number, p. 1067), contains an article by Mr. N. Fairclough on the best thickness of strips for use in the vacuum bolometer. This author employs the same general differential formula that we published at page 48 of Volume IV of these Annals, and he also uses the same letters that we did to represent physical quantities. He adapts his computations to platinum bolometer strips of the same length and width that we employ. He finds, however, a preference for strips much thinner than those we computed to be the best, and indicates a sensitiveness about 50 per cent greater for his best thickness over that for the thickness we recommended.

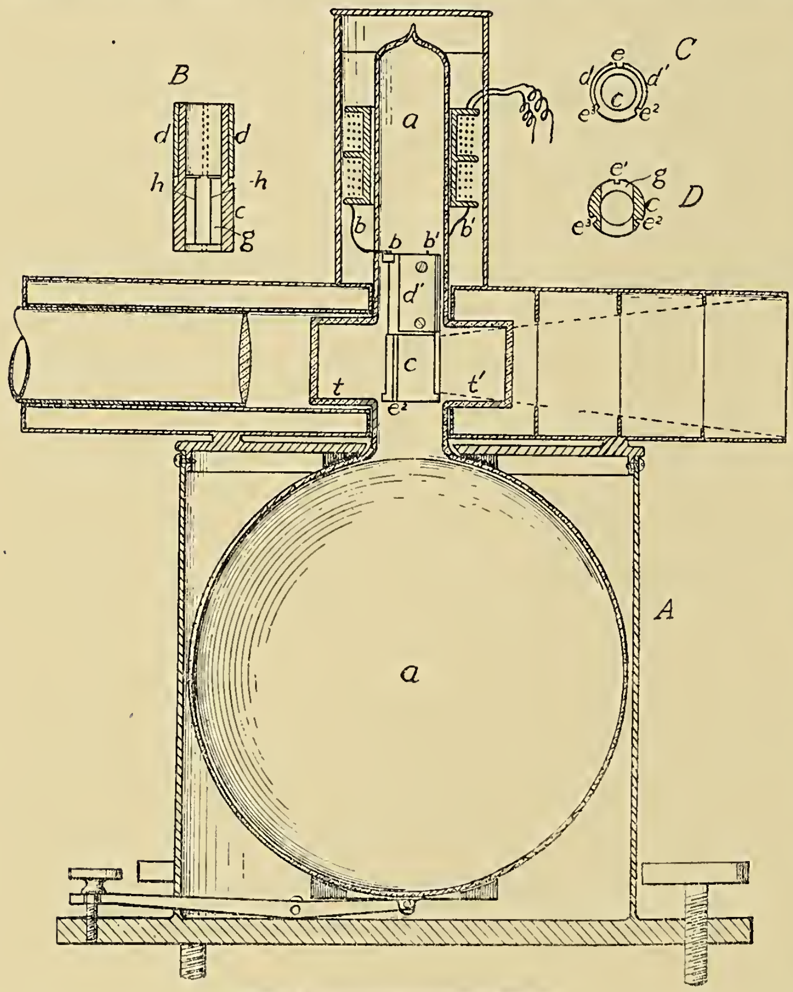


Figure 9.—Vacuum bolometer diagram

Like ourselves the author was unable to fully integrate the differential equation $\frac{d^2\theta}{dx^2}+A\theta^4+B=0$. Having performed one integration thereon, he made use of a mechanical method for the second integration. Instead, we had proceeded directly to expand the temperature of the strip into a series as a function of linear distance from its center, so that our methods of attack were independent of his.

In order to discover the cause of the discrepancy of result, we have carefully checked our process and computations. We find that for all thicknesses of the bolometer strip from 12×10^{-5} cm and upwards, our series is satisfactorily convergent, when terms to x^6 are employed therein. But in our earlier application of the series we had employed other derived series which seemed, perhaps, not sufficiently exact.[1] Therefore, we have now substituted another method of procedure, and have recomputed the data for strips of various widths. These revisions follow, but must be introduced by a quotation from Annals IV.

Let θ = the absolute temperature of the bolometer tape.
k = the thermal conductivity of the material.
$2l$ = length of tape.
m = width of tape.
n = thickness of tape.
γ = electrical conductivity per cm^3 of the material.
x = distance from center of the tape to any point upon it.
σ = Stefan's constant of radiation.
i = electric current in the tape.
θ_1 = absolute temperature at the point where $x=l$, that is to say, = absolute temperature of the surroundings.

Let us assume the strip to be in vacuum, perfectly black on one face, perfectly reflecting on all others, so that the radiation from the black face and the conduction along the strip are the only means of cooling it.[2]

The problem is to determine the steady state of temperatures under the given current conditions subject to the boundary conditions as follows:

$$\frac{d\theta}{dx}=0 \text{ when } x=0,\ \theta=\theta_1 \text{ when } x=l$$

Consider a section of the tape of length dx at the place x. It receives heat from the current, as follows: $\frac{0.24i^2}{\gamma mn}dx$.

It loses heat by radiation as follows: $\sigma(\theta^4-\theta_1^4)mdx$

It gains heat by conduction as follows: $kmn\frac{d^2\theta}{dx^2}dx$.

Summing these terms, we find the following equation:

$$kmn\frac{d^2\theta}{dx^2}dx+\frac{0.24i^2}{\gamma mn}dx-\sigma(\theta^4-\theta_1^4)mdx=0$$

Whence:

$$\frac{d^2\theta}{dx^2}-\frac{\sigma\theta^4}{kn}+\frac{0.24i^2}{k\gamma m^2n^2}+\frac{\sigma\theta_1^4}{kn}=0$$

For simplicity, let

$$\frac{\sigma}{kn}=-A \text{ and } \frac{0.24i^2}{k\gamma m^2n^2}+\frac{\sigma\theta_1^4}{kn}=B$$

Then the equation becomes:

(1) $$\frac{d^2\theta}{dx^2}+A\theta^4+B=0$$

We have not been able to solve the equation generally, hence we make the assumption:

$$\theta=a+bx+cx^2+dx^3+ex^4+fx^5+gx^6+\ \ldots$$

[1] We note certain errors: Equation 5 of Annals IV, p. 48, was erroneously transcribed from our original notes, but this error in the book did not affect the computations we published. As we no longer use equation 5, we do not correct it here. On p. 49 of Annals IV, Case I, for 0.004 read 0.0004.

[2] These assumptions approximate the facts. Solar rays received are almost fully absorbed by the lampblack paint on the front of the strip. Long-wave rays proper to the temperature are given out freely, though not perfectly by the lampblacked face. The unblacked surfaces, however, are highly reflecting for these long-wave rays and emit them but slightly.

Substituting this value of θ in equation (1), we have:

$$(2)\qquad \theta=a-\frac{Aa^4+B}{2}x^2+\frac{a^3A(a^4A+B)}{6}x^4-\left[\frac{Aa^2}{20}(Aa^4+B)^2+\frac{A^2a^6}{45}(Aa^4+B)\right]x^6+\ldots$$

In equation (2) $\theta_0=a$ when $x=0$, and $\theta=\theta_1$ when $x=l$. Hence by assuming values of θ_0 and θ_1 we are able to compute the distribution of temperature along the tape for all values of x less than l corresponding to values of the length, breadth, and thickness of the bolometer tape suitable to solar work.

Putting $x=l$ in equation (2), we have:

$$(3)\qquad a=\theta_1+\frac{l^2}{2}(Aa^4+B)-\frac{Aa^3l^4(Aa^4+B)}{6}+l^6\left[\frac{Aa^2}{20}(Aa^4+B)^2+\frac{A^2a^6}{45}(Aa^4+B)\right]+\ldots$$

* * * * * * *

We have assumed tapes of fixed length, $2l=1.6$ cm, but of various widths and thickness, as well as of different materials, and we have taken the value of θ_1 at 290° abs. C. We have taken the value of $\theta_0=a$, either at 350° or 400°. With these various conditions we have computed from equation (3) the values of B and from these the values of θ corresponding to the different values of x, from $x=0$ to $x=l$, and then the changes in these values, corresponding to a change di, which for the first case we took $\frac{1}{100}$ part of i itself. In all subsequent cases we took such values of di that the change of energy occurring in the tape (corresponding to the change in the heat electrically produced, i^2r) should be the same as in the first case for which we took the value $di=\frac{1}{100}$ part of i.

Thus, as the reader will see, instead of employing a fixed quantity of radiation and determining the effect it will have upon the temperature of the vacuum bolometer strip, we have done what amounts to the same thing. For we have changed the quantity of the uniformly distributed electrical heating by a constant amount, by making a supposed increase in the current strength in the bolometer tape, and by determining the change of temperature occurring all along the tape corresponding to this constant change in the electrical energy introduced in it. Thus we are able to compare the efficiency of tapes of different dimensions and different materials under various conditions, such as would be possible in practice.

The first requirement is the value of B to satisfy these series, equations (2) and (3). From the terms of equation (3), including l^4 but excluding l^6, we have computed B corresponding to

$a=345°$, 350°, 355°, and 360°, and

$10^5n=12$, 20, 40, 80, and 120.

To test whether these values of B would well enough satisfy equation (2), we have entered equation (2) with the most unfavorable condition, $x=0.8$, and have tested each computed value of B. It proved that no changes were needed except for the thinnest strips for which $10^5n=12$ and 20. By slightly reducing computed B values in these cases, we reached completely satisfactory results in all cases.

The values of B as corrected follow:

$10^5n=$	12	20	40	80	120
$B_{345}=$	1053	695.6	431.3	300.7	258.1
$B_{350}=$	1117	739.3	461.4	323.2	278.3
$B_{355}=$	1181	783.6	490.8	345.9	298.6
$B_{360}=$	1244	829.2	521.1	367.1	318.7

As an example of the convergency of equation (2), and taking the most unfavorable case, where $10^5n=12$, $a=350$, and $x=0.8$, we have:

$$290=350-34.88-21.43-3.98=289.71$$

All the other values of B give quite as satisfactory results as this one.

Substituting in equation (2) the corrected values of B and corresponding values of n, we have computed values of θ for $a=345°$, 350°, 355°, 360°, and for $x=0.2$, 0.4, 0.6, 0.7 cm. From these results, which yield smooth curves, the values of θ have been obtained corresponding to $x=0.0$, 0.2, 0.4, 0.6, and 0.7.

Corresponding to the chosen values of a, B, and n, there are certain values of i which we have determined from the expression

$$B=\frac{0.24i^2}{k\gamma m^2n^2}+\frac{\sigma}{kn}\theta_1^4$$

Having computed these values of i, we drew smooth curves of (i, θ) for $x=0.0$, 0.2, 0.4, 0.6, and 0.7 cm.

We then proceeded to compute values of i applicable to each value of n, in the case $i=i_{350}$. This computation is made by the formula

$$\delta i=(.0168)\ (.000168)\frac{i}{n}$$

In this way our new results are comparable with those of Annals IV. They are designed to give the rise of temperature, $\Delta\theta$, corresponding to equal increments of energy, electrically introduced, at times when the strips are already raised by current to central temperatures of 350° absolute C.

By entering the (i, θ) curves with values i_{350} and $i_{350}+\delta i$, we obtained values $\Delta\theta_{350}$ corresponding to these increments, δi, Having plotted these values of $\Delta\theta_{350}$, we determined mean values of $\Delta\theta$ applicable to the whole bolometer strip.

In the following tables, we assemble the new results applicable to platinum bolometer strips in vacuum. These strips are assumed perfectly black in front, perfectly reflecting behind. In each case the strip is 1.6 cm in length and 0.01 cm in width. An electric current is employed sufficient to heat the center of the strip 60° above the surroundings which are assumed as at 290° absolute C. It is assumed that the balancing coils in the Wheatstone's bridge are of large resistance compared to the bolometer strips and that the deflection of the galvanometer is proportional to the square root of its resistance. As shown on page 52 of Annals IV, the deflection of the galvanometer under these circumstances is proportional to the expression:

$$\frac{R\times i\times \text{mean}(\Delta\theta)}{2R+G}\sqrt{G}*$$

in which $2R$ is the double resistance of the strip, or $\frac{4l}{\gamma mn}$, and G is the galvanometer resistance. If N is the ratio of resistances of balancing coils to galvanometer, the most favorable case is when $G=2R\frac{N}{N+1}$.

* Mr. Fairclough pointed out in private correspondence the omission of the quantity R in the corresponding expression on page 52, Annals IV. This omission produced the discrepancy between our former results and his.

The above results, which seem thoroughly verified, are accordant with those of Mr. Fairclough. They differ slightly from those of Volume IV of these Annals because the earlier values depended on equation (4) of Volume IV, page 48, which is not exact. They differ also considerably because the factor R was formerly omitted, as pointed out by Mr. Fairclough.

Since the radiometer has been substituted for the bolometer with advantage in studies of the spectra of the stars, we have not thought it worth while to revise the stellar part of our discussion of the vacuum bolometer in Volume IV of the Annals.

TABLE 6.—*Summary of computations for vacuum bolometer*

$x=$	0	0.2	0.4	0.6	0.7	0.8
$10^5n=12$ cm:						
$\theta=$	345	342. 88	335. 59	319. 96	307. 22	290
$\theta=$	350	347. 74	339. 88	322. 88	308. 95	290
$\theta=$	355	352. 61	344. 25	326. 01	310. 94	290
$\theta=$	360	357. 55	348. 92	329. 62	313. 28	290
$10^5n=20$ cm:						
$\theta=$	345	342. 44	334. 10	317. 88	305. 71	290
$\theta=$	350	347. 25	338. 22	320. 55	307. 23	290
$\theta=$	355	352. 05	342. 35	323. 21	308. 70	290
$\theta=$	360	356. 86	346. 51	325. 96	310. 30	290
$10^5n=40$ cm:						
$\theta=$	345	342. 05	332. 80	316. 12	304. 44	290
$\theta=$	350	346. 78	336. 69	318. 42	305. 59	290
$\theta=$	355	351. 54	340. 66	320. 91	306. 93	290
$\theta=$	360	356. 29	344. 63	323. 38	308. 38	290
$10^5n=80$ cm:						
$\theta=$	345	341. 82	332. 08	315. 18	303. 79	290
$\theta=$	350	346. 54	335. 92	317. 48	305. 02	290
$\theta=$	355	351. 28	340. 12	319. 76	306. 23	290
$\theta=$	360	355. 97	343. 60	322. 03	307. 43	290
$10^5n=120$ cm:						
$\theta=$	345	341. 73	331. 77	314. 69	303. 35	290
$\theta=$	350	346. 44	335. 58	316. 99	304. 57	290
$\theta=$	355	351. 14	339. 39	319. 22	305. 78	290
$\theta=$	360	355. 86	343. 24	321. 56	306. 83	290

$10^5n=$	12	20	40	80	120
$i=$	. 00714	. 01002	. 0168	. 0298	. 0428
$\delta i=$	. 000120	. 000143	. 000170	. 000192	. 000200
Mean $\delta\theta=$	1°25	1°06	0°75	0°51	0°35
$2R=$	34. 1	20. 5	10. 2	5. 13	3. 41
$G=$	33. 0	20. 0	10. 0	5. 00	3. 00
$10^3\times\frac{2Ri\times\text{Mean }\delta\theta}{2R+G}\sqrt{G}=$	26. 1	24. 0	20. 1	17. 2	13. 8

The results indicate that the sensitiveness for solar bolometers continues to increase for decreasing thickness of strips to the limits of the tabular values, which accords with the results of Fairclough. Experiments have shown, however, that strips of thickness less than $10^5n=40$ are difficult to construct and less steady in operation in a degree quite prejudicial to exact work. Basing our practice on our former erroneous results, we have hitherto preferred to employ strips of approximately $10^5n=100$, for which the sensitiveness according to our investigation is about 0.6 the maximum. That sensitiveness is about 0.8 as great as is calculated for $10^5n=40$, which, considering all things, we regard as the preferred value. In future we shall prefer the thickness $10^5n=40$, for which the resistance is about 10 ohms.

PYRHELIOMETER

Time Intervals

It was formerly our practice to time the readings of the silver-disk pyrheliometer by means of a watch, observing at 20, 120, 140, 240, 260, and 360 seconds after the beginning of a given minute for a complete observation with one instrument. It was necessary to determine from time to time the eccentricity of the second hand of each observer's watch and to apply corrections therefor in order to obtain sufficient accuracy of time intervals. As eccentricities of watch second hands are apt to change and as the determination of them is not altogether accurate or very easy, we introduced a new and better method of observing in the year 1925.

A pendulum beating half seconds is constructed with a heavy lead bob and invar shafts and hung on hardened knife edges with so little friction that the swing, once started, will go on with moderate amplitudes for at least an hour. At each time that the bob swings past its lowest position, it contacts electrically through a mercury cup with the modified escapement of a common alarm clock. An electrical condenser of about 1 micro-farad capacity is inserted in the circuit in parallel with the pendulum circuit to cut down sparking. By altered gearing the minute hand of the clock is caused to revolve once in 10 seconds, and the hour hand in 2 minutes. At each complete revolution the minute hand rings a bell electrically. The observer, by glancing at the clock face, and noting only roughly the march of the hour hand, makes every reading according to the eye and ear method. He has the advantage of the accuracy of the pendulum, as interpreted by the loud ticks of the escapement, and emphasized by the bell at the instant of each reading.

Pyrheliometer Vestibule

At Mount Harqua Hala, as stated above, the summer months brought very hazy skies. We noticed that during these months many values of the solar constant seemed unexpectedly high. We were led to attribute this to excessive sky light observed by the silver-disk pyrheliometer in the region of sky closely surrounding the sun. The original vestibule of the silver-disk pyrheliometer exposed each point on the silver disk to a cone of sky 10° 38′ in diameter.

It will be recalled that in substance our determination of the solar constant consists in multiplying the reading of the pyrheliometer by the computed ratio of the area which a bolograph taken outside the atmosphere would embrace compared to that of one taken at the earth's surface. In determining that ratio of areas of bolographs, the sky light plays no part, for the optical train of the spectrobolometer admits the sun only, and practically nothing of its sky surroundings. Therefore, there is nothing in the ratio of bolographic areas tending to compensate error of the pyrheliometer reading due to its having observed bright sky surrounding the sun. Exact pyrheliometry is, in short, the fundamental basis of solar-constant determinations.

Tests of the magnitude of this sky-light error in pyrheliometry had been made in Washington many years ago. In these tests two pyrheliometers were compared, one with the usual vestibule, the other with a diaphragm about 1 m in front, in which was an aperture just sufficient to fully expose the instrument to the sun. The results obtained were stated as follows:[3]

> 1. As to the effect of variations of the light of the sky, it might seem that since the pyrheliometer is exposed to about 80° of solid angle, of which the sun occupies only about 0°.2, the sky light might be quite considerable. To test this question a screen which limited the solid angle to 5° was fixed to one instrument, and another instrument with the usual arrangements was compared with it at Washington. No alteration of the relative readings due to the use of the screen could be found on a very clear day. On another day, less clear, a change of relative readings of about 0.5 per cent was found. On a very poor day the effect may reach 1 or even 2 per cent. On Mount Wilson the sky is so clear that its effect would be negligible.

At the time when these tests were made we did not expect ever to observe the solar constant on such hazy days as those sometimes employed on Mount Harqua Hala, nor did we regard errors of 0.5 per cent as important, so that the results seemed to be fully reassuring that the sky error is negligible.

New tests by a similar method were made at Mount Harqua Hala and also at Montezuma, as follows:

Mount Harqua Hala, Ariz., February 4, 1925.—Pyrheliometers A. P. O. 10 and S. I. 32 were provided with screens situated 100 cm in front of their silver disks, each screen pierced with a circular aperture 4.5 cm in diameter. Thus each point on the silver disks was exposed to a spherical angle of 0.00027 hemisphere. Both instruments were read alternately throughout the afternoon, as thus screened and again in their usual condition. In the latter condition they had in those days screens 20 cm in front of their silver disks, each pierced with circular apertures 3.7 cm in diameter. In that condition each point of the disk was exposed to a spherical angle of 0.0046 hemisphere. The sky on February 4, 1925, was noted as "extremely hazy." This fact is supported by the evidence that the observed corrected rise of temperature in 100 seconds was only 3°.25 and 2°.05 at air masses 2.8 and 4.8 respectively. On a

[3] Annals, vol. III, p. 51.

good clear day, November 10, 1920, at Harqua Hala, the corresponding rise of temperature at these air masses was 3°67 and 3°00, respectively.

The average diminution of reading found on February 4, 1925, caused by limiting the area of sky observed as above specified, was 2.44 per cent. Though the day, indeed, was "extremely hazy," so much so as to be exceptional, yet the magnitude of the difference was so great that we were convinced of the need to provide instruments of more restricted apertures, as we shall describe below.

Montezuma, Chile, March 12, 24, and 25, 1925.—Pyrheliometer S. I. 17 was provided with a limiting circular aperture 3.2 cm in diameter, situated 50 cm in front of the silver disk. This exposed each point of the silver disk to a spherical angle of 0.00054 hemisphere. In this condition it was compared with pyrheliometer S. I. 29, of which each point was exposed as usual to a spherical angle of 0.0046 hemisphere. In some experiments the instruments were read simultaneously and observers were interchanged after each four readings, so as to eliminate personal equation. In others, one observer read both instruments with one minute between, but reversed the leading instrument after each four readings.

In all, 14 comparisons were made on a very hazy day, March 24, 1925, between S. I. 17 with the special aperture and S. I. 29 with the usual aperture, resulting in the mean ratio 17/29 = 1.0145. On March 12, 24, and 25, in all, 24 comparisons were made between the two instruments, both being in their usual condition, resulting in the mean ratio 17/29 = 1.0164. The difference of 0.2 per cent, though in the expected direction, even if significant, is very small. Furthermore, it is representative of unusually hazy conditions.

These observations failed to indicate definitely that the sky added appreciably to the observed pyrheliometer readings at Montezuma, even on unusually hazy days. It is indeed possible that a small sky error, amounting to a few tenths of 1 per cent, may affect Montezuma pyrheliometry on very hazy days. If the work were to be begun there anew, it would be better to reduce the angular aperture of the pyrheliometers by the use of a longer vestibule. We hesitated, however, to make any change there, because extensive statistical studies had rendered the system of observations at Montezuma definitive. Any change of the apparatus or methods would disturb the continuity and require new statistical studies with a delay of several years in the publication of Montezuma results. Moreover, the system of corrections which the statistical studies had fixed must tend to eliminate the errors, if any, due to sky effect.[4] The several considerations decided us to leave the apparatus at Montezuma unaltered.

[4] If, for instance, hazy skies tend to raise the solar constant owing to pyrheliometer error, they will be skies which also yield high values of the so-called "function," used in the short method of solar-constant determination. Hence in applying to solar-constant results statistically-determined corrections which vary with the value of the function, subtractive values will be found for conditions of high "function" which will, in fact, approximately represent and correct for the supposed pyrheliometric error.

In North America, however, it was otherwise. We were about to remove the observing outfit from Mount Harqua Hala to Table Mountain, and thereby to institute a new series. Hence we introduced at the beginning of the observations new vestibules on the pyrheliometers as shown in Plate II. In the new arrangement at Table Mountain and at Mount Brukkaros (Pl. IV, fig. 2) the vestibule is 80 cm long and the diameter of outside aperture is 45 mm. It exposes each point of the silver disk to a cone of sky of 3° 13′ in diameter.

Dorno [5] indicates that the error from sky radiation may be serious. He has made photometric measurements, which should be applicable to our mountain stations as far as visible rays are concerned. He computes that on clear days the apparent increase of solar brightness by visible sky rays entering the old form of silver-disk pyrheliometer (whose cone is 10.5°) is about 1¾ per cent. Dorno states that, for the total radiation of all wave lengths, the sky brightness will be relatively considerably less, but not so much so as to be negligible. On hazy days, the effect may be much greater. He recommends the use of a lens, so as to form an image of the sun, and thus to permit the total elimination of the sky-radiation effect. It might even seem from Dorno's paper that our new vestibules would not sufficiently reduce the sky effect. Dorno, however, neglects three considerations which seem to me important.

In the first place, the pyrheliometer, it is true, receives scattered solar radiation from the sky, but it emits to the sky an excess of long-wave rays, owing to the higher temperature of its receiving surface than the effective temperature of the sky. Dr. A. K. Ångström has reported measurements [6] of total radiation, observed with blackened strips at Bassour, Algeria (elevation 1,160 m) in daytime. The measurements were made in September, 1912. I quote as follows:

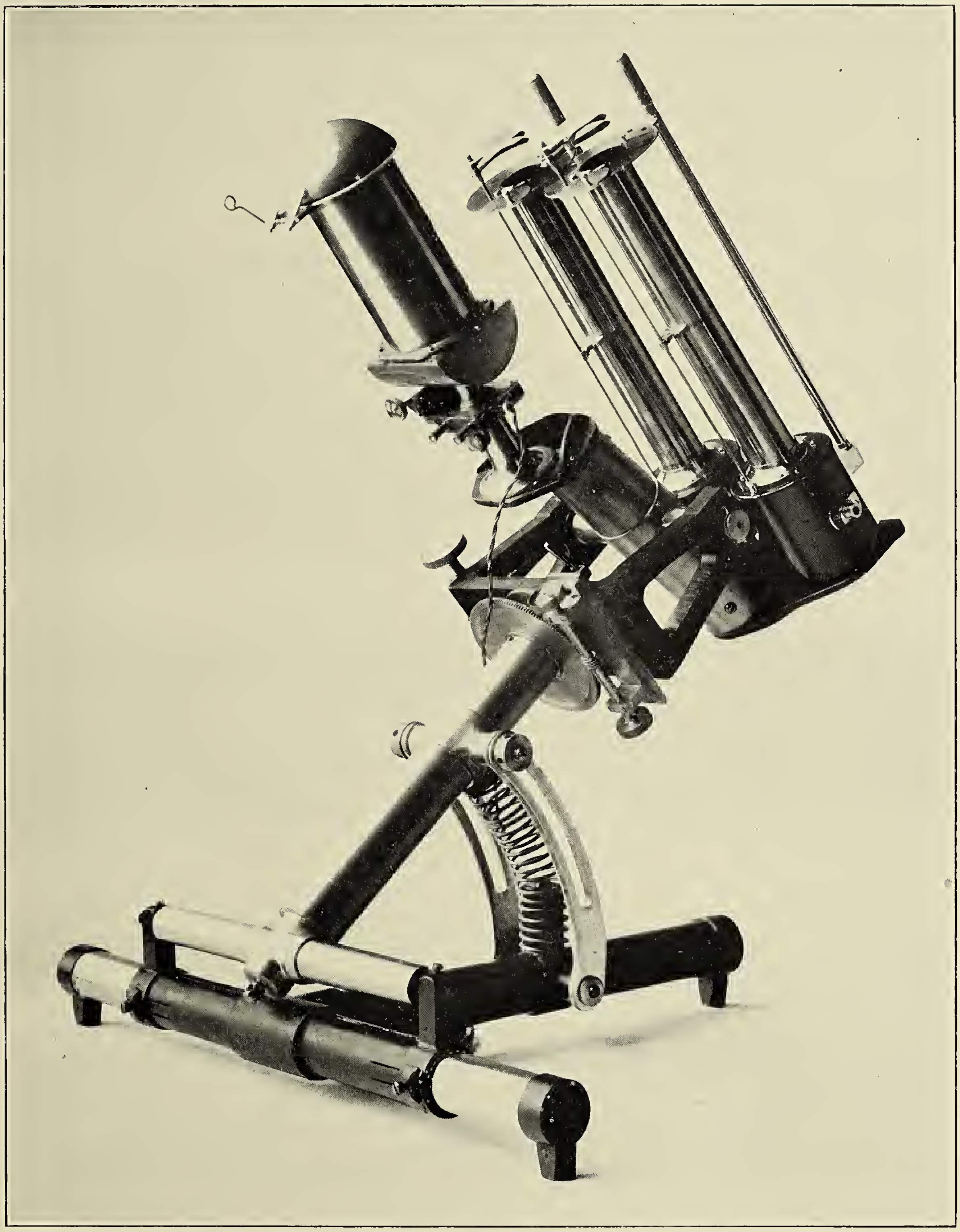
The sky was overcast with a faint yellow-tinted haze ascribed * * * to the eruption of Mount Katmai. * * *

Table XI.—*Radiation of the sky (calories)*

	Sept. 5	Sept. 6	Sept. 7	Mean
Before sunrise	−0. 169	−0. 205	−0. 208	−0. 194
Noon	+. 062	+. 092	+. 047	+. 067
After sunset	−. 208	−. 225	−. 220	−. 218
Total sky radiation	+. 250	+. 307	+. 261	+. 273

From the table it may be seen that (at noon) there is always an access of radiation from the sky, indicating that the diffuse radiation from the sky was always stronger than the outgoing effective temperature radiation.

[5] Monthly Weather Review, December, 1925.
[6] Smithsonian Miscellaneous Collections, vol. 65, no. 3, Table XI.



Improved Silver-disk Pyrheliometers and the Pyranometer

But the difference was small, averaging only 0.07 calorie for the whole sky, on the average of three days of unusual haziness. As the pyrheliometer in its original form sees only about 0.0046 of the sky hemisphere, the excess of incoming sky rays over outgoing long-wave rays attributable to the average sky cone, equal to that seen by the pyrheliometer at that rate would be only 0.0003 calorie. But according to our own observations[7] the sky, out to 5°.5 from the sun's center, averages nine times as bright for total radiation, on Mount Wilson, as the average of the sky, taken as a whole. Hence, the correction becomes about 0.0027 calorie, which is negligible. Allowing for cosine effect near the horizon, this may be increased to 0.005 calorie, but will still be nearly negligible. As this estimate is based on Ångström's measures taken on very hazy skies at an elevation of only 1300 m, it seems ample for our much higher mountain stations for usually clear days.

If the sky effect, which is the excess of incoming over outgoing radiation, then, is generally absolutely negligible at our mountain stations for the old form of vestibule of the silver-disk pyrheliometer, much more must it be negligible, except perhaps under very extraordinarily hazy sky, with the new vestibule. For whereas the old form exposed each point of the silver disk to 0.0046 hemisphere, the new form exposes only to 0.0004 hemisphere.

A second consideration, however, still further clears the situation. Our concern is rather for relative than for absolute values of the solar constant. Hence, since on every day the bright sky close to the sun contributes something more or less of scattered sunlight than it receives of long-wave rays from the pyrheliometer, the question as it concerns solar variability is merely how much greater is this small difference of sky rays on hazy days than on clear ones. Therefore not the entire amount, but only a part of the sky error affects the comparability of successive days of solar-constant observations. Moreover, in the third place, as stated above, even the solar-constant error due to this variable fraction of the sky effect tends to be eliminated by the statistical corrections which we shall treat in detail at a subsequent page.

We therefore conclude that so far as they affect our measurements of solar variation, the sky rays received in our present pyrheliometric instruments from the vicinity of the sun are negligible.

As the long vestibules employed at Table Mountain and Mount Brukkaros are unwieldy, we have introduced a less cumbrous improvement of the silver-disk pyrheliometer as now made at the Smithsonian Institution and furnished to investigators. This new form is shown in Plate VII. Its vestibule is 37 cm in length, with an outside aperture 37 mm in diameter. The outer aperture subtends 5° 48′ in angular diameter, as viewed from any point on the silver disk, and it exposes 0.0013 hemisphere.

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[7] Astronomical Journal, vol. 28, p. 131, Table IV, 1914.

Dust Protection

Although the silver-disk pyrheliometer is provided with a closely fitting shutter to exclude dust during periods of disuse, the wind sometimes carries dust which settles within the vestibule during observations. Sometimes, too, the observers may neglect to close the protecting shutter when observations are concluded. Our attention was strongly fixed on this matter when, on April 24, 1924, Aldrich, at that time field director in Chile, noticed that the two silver disks which were employed for daily observations were very dusty.

To explain what occurred, we quote the following passage from Abbot's article in the Monthly Weather Review Supplement No. 27, issued December, 1926.

In addition to pyrheliometers S. I. No. 29 and No. 30 the Montezuma station is equipped with a third instrument, S. I. No. 17, which is laid aside and used only occasionally on very fine days for standardization purposes. The following mean results of many sets of observations indicate great constancy of the scale of the pyrheliometers used daily:

Date [1]	Mean ratio No. 17 / No. 29	Date	Mean ratio No. 17 / No. 29
Sept. 19, 1919	1. 0134	Mar. 12, 1925	1. 0180
Aug. 23, 1920	1. 0112	Mar. 24, 1925	1. 0163
Nov. 21, 1921	1. 0166	Mar. 25, 1925	1. 0150
Apr. 29, 1924	1. 0160	May 6, 1926	1. 0155
May 2, 1924	1. 0134		
June 16, 1924	1. 0155	Adopted ratio	1. 0155
Aug. 24, 1924	1. 0136		

[1] Later comparisons are given in Chapter IV.

Various comparisons were made with other pyrheliometers, including one, S. I. No. 5, which was compared at Washington, carried to Chile in 1921 by the writer, and again compared at Washington after his return. For the years 1920, 1921, 1924 (after April 24), and always hereafter, to reduce the readings in the table to calories per square centimeter per minute according to the Smithsonian scale of 1913, multiply by 0.3629.

In the years 1922 and 1923, unfortunately, the factor was not so certain, but has been determined as follows:

It is necessary to state that the observers who were at Montezuma in 1921 and 1922 did not maintain the work with due diligence or keep the station and instruments in proper order. When L. B. Aldrich succeeded as field director, in December, 1922, he had many troublesome things to put to rights, and in addition, was ill for a time and embarrassed by illness of his family. He had besides to introduce the new vestibuled pyranometer and to make the enormous mass of computations by the long method necessary to lay a basis for the short-method work as modified by the change in pyranometer.

Owing to these preoccupations, he unfortunately assumed that the pyrheliometers were in good condition, and was shocked to discover on April 24, 1924, that their black surfaces were covered with dust. His predecessor had not informed him of the presence of Pyrheliometer S. I. No. 17, but he was acquainted by cable of the fact, and within a few days after removing the dust he found, on April 29, 1924, that the pyrheliometers in daily use were in perfect accord with their condition as of November 21, 1921, when the writer made a comparison whose result is quoted above. The removal of the dust on April 24 raised the readings of each of the instruments by 2.8 per cent.

Mr. Aldrich is certain that the dust did not come on during his regime, so that it may be provisionally assumed that from December 20, 1922, to April 24, 1924, the dust was constant. The next question is how the dust accumulated between November 21, 1921, and December 20, 1922; whether gradually or in one or more sudden accessions.

P. E. Greeley recollects that in anticipation of Mr. Aldrich's arrival he employed a man to sweep the buildings about December 15, 1922. As it is quite possible that the covers of the pyrheliometers in daily use were carelessly left open, it was hoped that it might prove that all the dust settled on their black surfaces at that time. To test this question, the writer selected the following days in which the pyrheliometric results obtained just before and just after the date of sweeping are compared with days of other years having similar atmospheric humidity and transparency as indicated by ρ/ρ sc and the function, F, which we use to determine atmospheric transmission coefficients in the "short method."

Comparison of similar days

[Days prior to December 15, 1922]

	ρ/ρ sc	F.	Pyrh.	Harqua Hala solar constant	Δ Pyrh. (per cent)	Δ Solar constant (per cent)
Air mass 2.0						
Oct. 4, 1922	0. 645	180	4. 090	1. 923		
Oct. 5, 1922	. 657	181	4. 110	1. 924		
Oct. 6, 1922	. 639	190	4. 157	1. 938		
Oct. 10, 1922	. 633	186	4. 099	1. 918		
Mean	. 644	186	4. 114	1. 926		
Oct. 5, 1921	. 648	186	4. 126	1. 932	+0. 3	+0. 3
Dec. 2, 1922	. 769	207	4. 170	1. 931		
Nov. 25, 1921	. 769	192	4. 178	1. 964	+0. 2	+1. 7
Air mass 1.5						
Oct. 5, 1922	. 687	154	4. 284	1. 924		
Oct. 6, 1922	. 689	142	4. 308	1. 938		
Mean	. 688	148	4. 296	1. 931		
Sept. 28, 1921	. 680	148	4. 386	(1. 938)	+2. 1	(+0. 4)
Nov. 30, 1922	. 796	145	4. 486	(1. 931)		
Nov. 23, 1921	. 795	145	4. 527	1. 956	+0. 9	(+1. 3)
Mean					+0. 9	+0. 9

Comparison of similar days—Continued

[Days subsequent to December 15, 1922]

	ρ/ρ sc	F.	Pyrh.	Harqua Hala solar constant	Δ Pyrh. (per cent)	Δ Solar constant (per cent)
Air mass 2.0						
Jan. 11, 1923	0. 510	463	3. 853	1. 924		
Jan. 17, 1923	. 487	480	3. 770	(1. 928)		
Mean	. 498	472	3. 811	1. 926		
Jan. 14, 1921	. 495	458	3. 966	1. 975	+3. 9	(+2. 5)
Air mass 1.5						
Jan. 11, 1923	. 552	358	4. 068	1. 924		
Jan. 14, 1922	. 554	376	4. 241	1. 952	+4. 3	+1. 5
Jan. 17, 1923	. 546	360	3. 962	(1. 929)		
Jan. 14, 1921	. 552	362	4. 195	1. 975	+5. 8	(+2. 4)
Jan. 13, 1923	. 669	162	4. 266	1. 933		
Dec. 1, 1921	. 673	228	4. 389	(1. 954)	+3. 0	(+1. 1)
Mean					+4. 3	+1. 9

From these results it seems to be shown that for days prior to December 15, 1922, the pyrheliometric readings were in close accord with readings on days of nearly identical atmospheric conditions in the preceding year, when the pyrheliometers were known to be in good condition. On the other hand, for days of January, 1923, the pyrheliometer readings were much lower than on similar days of former years, and when allowance is made for change of solar constant, as determined at Mount Harqua Hala, the difference comes out 2.4 per cent.

Mr. Aldrich determined (by numerous observations) the effect of removing the dust by comparing both pyrheliometers, Nos. S. I. 29 and S. I. 30 with the pyranometer. As the two pyrheliometers maintained their usual scale relatively to each other all through the period of dust, only the mean result is given. These comparisons are as follows:

Pyrheliometric determinations of constant of pyranometer

		Δ Per cent
Feb. 27, 1924	13. 37	
Apr. 11, 1924	13. 28	
Mean	13. 33	
Apr. 26, 1924	13. 72	+2. 8

This indicates that the dust cut down the pyrheliometer readings by 2.8 per cent. This is in close accord with the indirect result just given, but is of course the definitive measure of the dust effect.

In order to check the matter still further and show that the constants of the pyrheliometers remained unaltered from January, 1923, to April 24, 1924, when the dust was removed, the following comparisons are added:

	ρ/ρ sc	F.	Pyrh.	Harqua Hala solar constant	Δ Pyrh. (per cent)	ΔSolar constant (per cent)
Air mass 2.0						
Mar. 8, 1923	0. 682	208	4. 092	(1. 920)		
Mar. 1, 1924	. 683	261	4. 042	1. 934	−1. 2	(+0. 7)
Mar. 9, 1923	. 624	258	3. 975	1. 920		
Mar. 3, 1924	. 613	264	3. 979	(1. 920)	+0. 1	(0. 0)
Apr. 19, 1923	. 693	183	4. 014	(1. 920)		
Apr. 22, 1924	. 697	155	3. 970	1. 919	−1. 1	(−0. 0)
Air mass 1.5						
Mar. 8, 1923	. 776	173	4. 285	(1. 920)		
Mar. 9, 1924	. 785	185	4. 270	1. 919	−0. 3	(−0. 0)
Mar. 13, 1923	. 580	253	4. 112	1. 929		
Mar. 7, 1924	. 599	247	4. 140	1. 900	+0. 7	−1. 5
Apr. 2, 1923	. 712	185	4. 186	(1. 920)		
Apr. 1, 1924	. 703	159	4. 173	1. 934	−0. 3	(+0. 7)
Mean					−0. 3	−0. 0

In view of all these results, it is thought that we may feel certain that the constants of pyrheliometers S. I. No. 29 and S. I. No. 30 were unchanged up to and including December 2, 1922, and were 2.8 per cent low from December 25, 1922 (Mr. Aldrich's first observation) to April 24, 1924, both inclusive. The days between December 2 and December 25 (not inclusive) are uncertain, as there are no suitable comparison days to test them against.

Hence to reduce to calories per square centimeter per minute: From the beginning to December 2, 1922, inclusive, and from April 25, 1924, to the end, inclusive, multiply the readings by 0.3629. From December 25, 1922, to April 24, 1924, inclusive, multiply the readings by 0.3731.

Immediately after this disturbing experience, all observers in the field were cautioned to be careful to close the special shutters whenever not actually observing; to brush off the silver disks with fine camel's-hair brushes occasionally; to make frequent comparisons of pyrheliometers in daily use with the extra pyrheliometers set aside as standards; and especially to make such comparisons before and after each brushing of the silver disks. Whenever appreciable corrections for dust seemed indicated, which fortunately was rarely, they were made as exactly as possible.

New Form of Pyrheliometer

Although the silver-disk pyrheliometer has served us well for many years, especially as regards constancy, the slowness of observing, the possibility of personal equation, and the appreciable sky exposure surrounding the sun which are characteristic of this instrument gave rise in our minds to another design. While this new form has not yet come into use, it has features of considerable interest.

In Figure 10 we show the principal parts of the new design. Two separate receivers are arranged with tubular vestibules and a common mounting so as to follow the sun simultaneously. They are used in compensation or balance, the one against the other, as in the Ångström pyrheliometer. That is to say, one receiver is to be electrically heated to the same extent that the other is heated by sun rays, but the two may be interchanged, so that alternately they are electrically heated. The solar rays are admitted by a vestibule, B, B'.

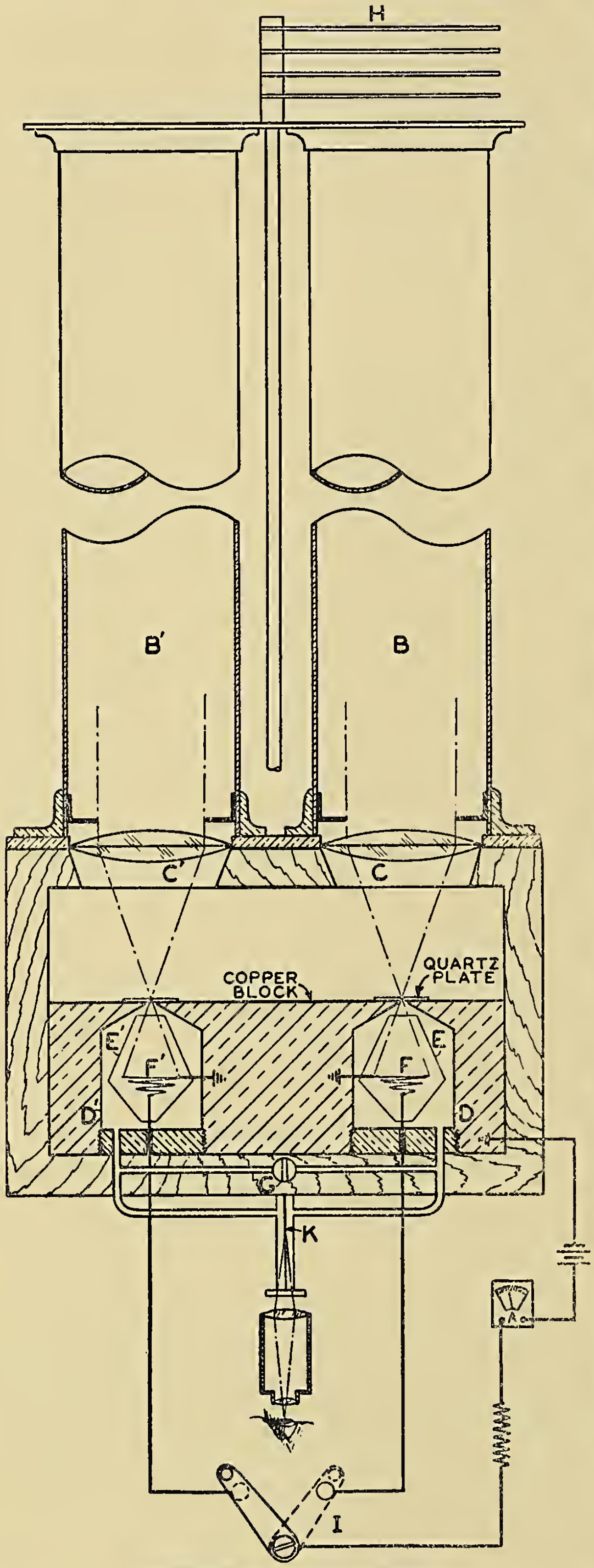


FIGURE 10.—Proposed pyrheliometer.

At C, C' are double convex quartz lenses each made up of two plano-convex lenses, separated by a thin diaphragm whose aperture limits the solar beam. These lenses C, C' converge the solar rays so as to be able to pass through a small aperture into the chambers D, D'. The opening of each chamber is guarded by a very thin quartz plate which is cemented on so as to make the chamber air-tight. Within the chamber the rays enter a thin-walled interiorly blackened inner chamber E, E', which incloses a blackened spirally disposed metal resistance strip of manganin, F, F', on which the rays are principally absorbed. It is this metal resistance strip to which compensatory electrical heating may be applied.

The two chambers D, D' are connected by small pipes to a manometer. A by-pass, G, is provided however which equalizes the pressures in the two chambers with each other and with the atmospheric pressure until observing begins.

The operation of the pyrheliometer will now be clear. When one of the shutters, H, is opened, sunlight is concentrated by a lens onto the resistance strip F, where the rays are mainly absorbed and produce their heat. Such as are reflected fall on the thin walls of the chamber E. But whether absorbed on F or on E they eventually communicate their heat at a constant rate to warm the air within the chamber, D, and thus to expand it over its initial condition.

This forces the manometer diaphragm away from its neutral position. But meanwhile electric current has been introduced in the resistance strip, F', of the other chamber C'. By careful adjustment of the strength of current the manometer is brought back to its initial position. Then the shutters H, are alternately opened and closed between observations, and by an associated switch, I, the electric current is shifted at each alternation of the shutters to the chamber not exposed to sun rays. By observing a series of current values in this way, the energy of the absorbed sun rays is determined in terms of compensating electrically introduced heat.

It will be noted that sky light is almost totally excluded from the chambers, since the apertures which lead into them are so very small. Of course it will be recalled by the reader in this connection that sky light, which comes from a practically uniformly illuminated extended surface, can not be concentrated by any lens at the focus to greater intensity than it would have with no lens. It will also be noted that the chambers are naturally approximately completely absorbing on account of their shape, without regard to the highly absorbing properties of their blackened interior surfaces.

Losses of radiation by reflection at the quartz lenses and plates must be corrected for, if the apparatus is to be used as an absolute instrument. Dust may collect on the upper lens surface, and both dust and films which may form on the various surfaces must be removed from time to time.

Hitherto the instrument has been in a developmental stage. Whether it will come into daily use remains uncertain. Its advantages over the silver-disk pyrheliometer, if successful, reside in its being an absolute instrument; in being quick-acting; in eliminating sky radiation; and in being free from error of personal equation.

PYRANOMETER

As noted on page 79 of Annals, volume IV, an abridged method of determining the solar constant of radiation was devised in 1919 at Calama, Chile. This method, which has been applied with modifications at each of our field stations, involves measurements by the pyranometer of the total scattered radiation coming from a circular region of the sky concentric with the sun, but excluding the sun itself. In our earliest application of this method, at Calama, we employed a hemispherical thimble of sheet metal, polished without, but black within, and closely surrounding the hemispherical glass screen of the pyranometer. In this thimble was cut centrally a circular aperture exposing the instrument to a cone of sky 38° in diameter. The sun was shaded off by means of a circular screen 15 mm in diameter, situated at 14.3 cm distance, and subtending about 6°.

The hemispherical thimble was found unsuitable for the reason that the different points of the sensitive strip of the pyranometer, 0.6 x 0.3 cm in area, although each exposed to cones of sky of substantially equal angular diameter, were not exposed to the same cones. Thus, extreme opposite corners of the strip would look out through cones whose axes made an angle of about 31° to each other. This led to noncomparability of readings at different altitudes of the sun above the horizon, besides greatly restricting the applicability of the short method on days partially cloudy.

To cure these troubles, we introduced in the year 1920, dating from the commencement of observing at Mount Harqua Hala, and in November, 1921, at Mount Montezuma,[8] a vestibule as shown diagrammatically in Figure 11. The vestibule is 15 cm long, with 4 diaphragms, of which the outer one is 7.7 cm in diameter, and exposes the instrument to a cone of sky 29° in diameter. At the center of this outer diaphragm is the sun shade, 18 mm in diameter, which hides a cone 7° in diameter, within which the sun occupies from 30′ to 33′ at different seasons. It is necessary to cover a region considerably larger than the sun in order to shade the whole of the aperture of the inmost diaphragm of the vestibule (16 mm in diameter) so as to prevent the sun rays from striking on the surface of the glass hemisphere and reaching the sensitive strip by scattering therefrom. The top of the vestibule is provided with a double-walled hemispherical shutter, polished without, black within.

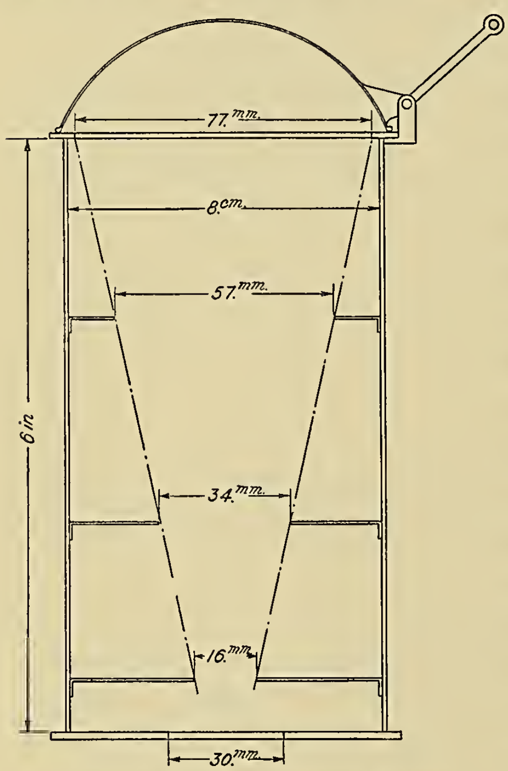


Figure 11.—Pyranometer vestibule. Diagram.

The pyranometer, with such a vestibule and shutter, is mounted on the same stand as the two pyrheliometers, so that the observer of the pyrheliometer keeps the pyranometer pointed toward the sun by the same adjustment that directs the two pyrheliometers. A cord attached to the pyranometer shutter, and running to the interior of the observatory, enables the bolometric observer to expose the pyranometer whenever opportunity offers during a bolographic run. Plates II and IV, fig. 2, show the arrangement of pyranometer and pyrheliometers.

Errors in Pyranometry

In August, 1927, a sudden increase was noted in the solar-constant results found on Table Mountain. On comparing all the elements of the determination

[8] This improved arrangement was not used regularly in the solar-constant observations at Montezuma until January, 1923.

it was found that the pyranometer values had suddenly increased by more than 10 per cent about August 12. Tests were made as soon as the change was thus located to see if the electrical constants of the pyranometer had altered. Nothing of this sort being found, comparisons of the pyranometer with the pyrheliometer were made on the measurement of the radiation of the sun. We are accustomed to remove the outer diaphragm of the pyranometer vestibule before such a comparison and to substitute for it a diaphragm with a small central hole suitable to admit sun rays and exclude sky rays. These comparisons disclosed no change in the pyranometer. For a time it was thought possible that the trouble came from a small displacement and slight tipping of the central sunshade attached to the usual sky diaphragm. A great many trials of one kind and another were made at Table Mountain, reported by letter to Washington, and others ordered by letter to Table Mountain, so that months went by without discovering or removing the cause of the trouble. Indeed it obviously grew worse as time went on.

At length, in September, 1928, Doctor Abbot visited the observing station at Table Mountain and, following a clue discovered by Mr. Moore, was fortunate enough to locate the trouble. In removing the outer diaphragm in August, 1927, it appears that some of the blackening had been rubbed away, so that the edges of the diaphragm became partly bright. Thus sunlight was reflected from them onto the sensitive strip. When reblackened in September, 1928, the sky readings immediately returned nearly to normal. A duplicate diaphragm is now preserved as a test piece to be substituted from time to time. Also a second pyranometer whose vestibule is nearly identical with the other is compared on sky observations from time to time.

Several questions then arose: Did the error begin suddenly in August, 1927, or did it gradually accumulate over a long period previously? What was the approximate magnitude of the error at all times up to the time of its discovery? Could the error be allowed for so that the solar-constant determinations would become trustworthy?

Fortunately the solar-constant values are very insensitive to changes in the pyranometer. It requires, in fact, a change of approximately 20 per cent in the pyranometer to produce 1 per cent change in the solar constant. With this in view, it seemed probable that corrections of sufficient accuracy could be determined.

The procedure adopted was as follows: For each month of the year in the several years since observing was begun at Table Mountain (in December, 1925) the pyranometer observations were collected in three groups corresponding to air masses 1.5, 2.0, and 2.5, respectively. Each group was arranged in order of increasing quantities of precipitable water. It soon appeared, as shown in Table 3, that a yearly march of pyranometry occurred, even on days of equal precipitable water, so that the months of February, March, April, May, and part of June showed far brighter skies near the sun at Table Mountain than the other months. All other months gave nearly constant values under equal conditions as regards precipitable water. This yearly range, shown in Figure 7, being allowed for, it fortunately appeared that no appreciable change had occurred prior to August, 1927, in the average monthly readings of the pyranometer as selected to represent comparable conditions. The change had occurred suddenly about August 12, 1927. It was doubtless caused by handling the outer diaphragm of the vestibule and thereby rubbing off blackening when exchanging it for the solar aperture preparatory to making a standardization on the solar radiation. The numerous comparisons made later to locate the trouble had aggravated it by further handling. It is probable that some deterioration occurred in the blackening lower down near the sensitive strip also, for the instrument did not return quite to normal after reblackening the outer diaphragm.

On comparing the assembled selected pyranometry of the abnormal period month by month, with the standard of monthly means set by the unaffected results observed between December, 1925, and July, 1927, we arrived at the following smoothed ratios, Table 7, as best representing the march of the error. The values give the ratio of the abnormal to the normal pyranometer readings. They are determined by comparing abnormal monthly means to the normal monthly means derived during the earlier unaffected period.

TABLE 7.—*Ratios of monthly pyranometry to standard at Table Mountain. Air mass, 2.0. Precipitable water, 0–10 mm*

Ratios	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Observed	--------	--------	--------	--------	--------	--------	--------	*1927* 1. 12	1. 15	1. 23	1. 12	1. 20
	1928 1. 20	--------	--------	--------	--------	--------	1. 15	1. 27	{1. 24, 1. 12}	1. 08	1. 08	1. 18
Smoothed	--------	--------	--------	--------	--------	--------	--------	*1927* 1. 135	1. 143	1. 150	1. 156	1. 163
	1928 1. 170	1. 177	1. 183	1. 190	1. 197	1. 204	1. 211	1. 218	{1. 225, 1. 08}	1. 08	1. 08	1. 08

Knowing the nature of the error, it was clear that the correction could not properly be made in terms of percentage. Instead, a computed value in calories per cm^2 per minute ought to be subtracted from the pyranometer observations. For since the error is caused by reflected sun rays, the value of the correction must be directly proportional to the intensity of solar radiation as measured by the pyrheliometer at the time of observation. Accordingly, we determined the mean values of the pyrheliometer corresponding to air masses 1.5, 2.0, 2.5, during the months July to January, inclusive, when a nearly uniform brightness of the sky prevails under equal quantities of precipitable water. We determined also the mean corrections in calories corresponding to the percentage corrections already etdermined. Thus we came at length to the following tabular corrections to be applied to pyranometry.

TABLE 8.—*Subtractive corrections to Table Mountain pyranometry. Expressed in calories*

Month	1927	1928	Month	1927	1928
January		0.0026	August	0.0024	0.0030
February		.0027	September	.0024	{ .0030 / .0019 }
March		.0027			
April		.0028	October	.0025	.0019
May		.0028	November	.0025	.0019
June		.0029	December	.0026	.0019
July		.0029			

These tabular values are to be multiplied by the ratio of observed pyrheliometer to the standard value, which, for air mass 2.0 is 1.480, and for air mass 2.5 is 1.425.

The latter entries in Table 8, following September, 1928, depend on other evidence. Hardly had the source of error been reached, and as it was supposed corrected, when Field Director Moore communicated his impression, based on comparisons with another instrument, that the pyranometer was still reading 10 per cent too high, although the vestibule had been reblackened. To test this matter, we reduced the entire series of Table Mountain observations of the solar constant of radiation covering the period December, 1925, to September 11, 1928, and applied the determined statistical corrections for humidity, ozone, and sky brightness, and erroneous pyranometry. We also reduced the later observations in the same way, excepting that we made no allowance for the supposed remaining error of pyranometry. Then we computed the ratio of final corrected solar-constant values: $\frac{\text{Montezuma}}{\text{Table Mountain}}$ for every good day observed at both stations. We next found the mean of these ratios before and after September 11, 1928. It was immediately perceived that Table Mountain values began to run systematically too high with respect to Montezuma from September 11, 1928, so that Mr. Moore was right in his impression that the Table Mountain pyranometer is still reading high. Hence, we have determined a new correction to pyranometry applicable since September, 1928, choosing it so as to close the discrepancy with Montezuma, which is as follows:

Air mass	Correction in cal. per cm² per min.
1.5	$-0.0019\ \frac{\text{Pyrheliometer}}{1.51}$
2.0	$-0.0019\ \frac{\text{Pyrheliometer}}{1.48}$
2.5	$-0.0019\ \frac{\text{Pyrheliometer}}{1.425}$

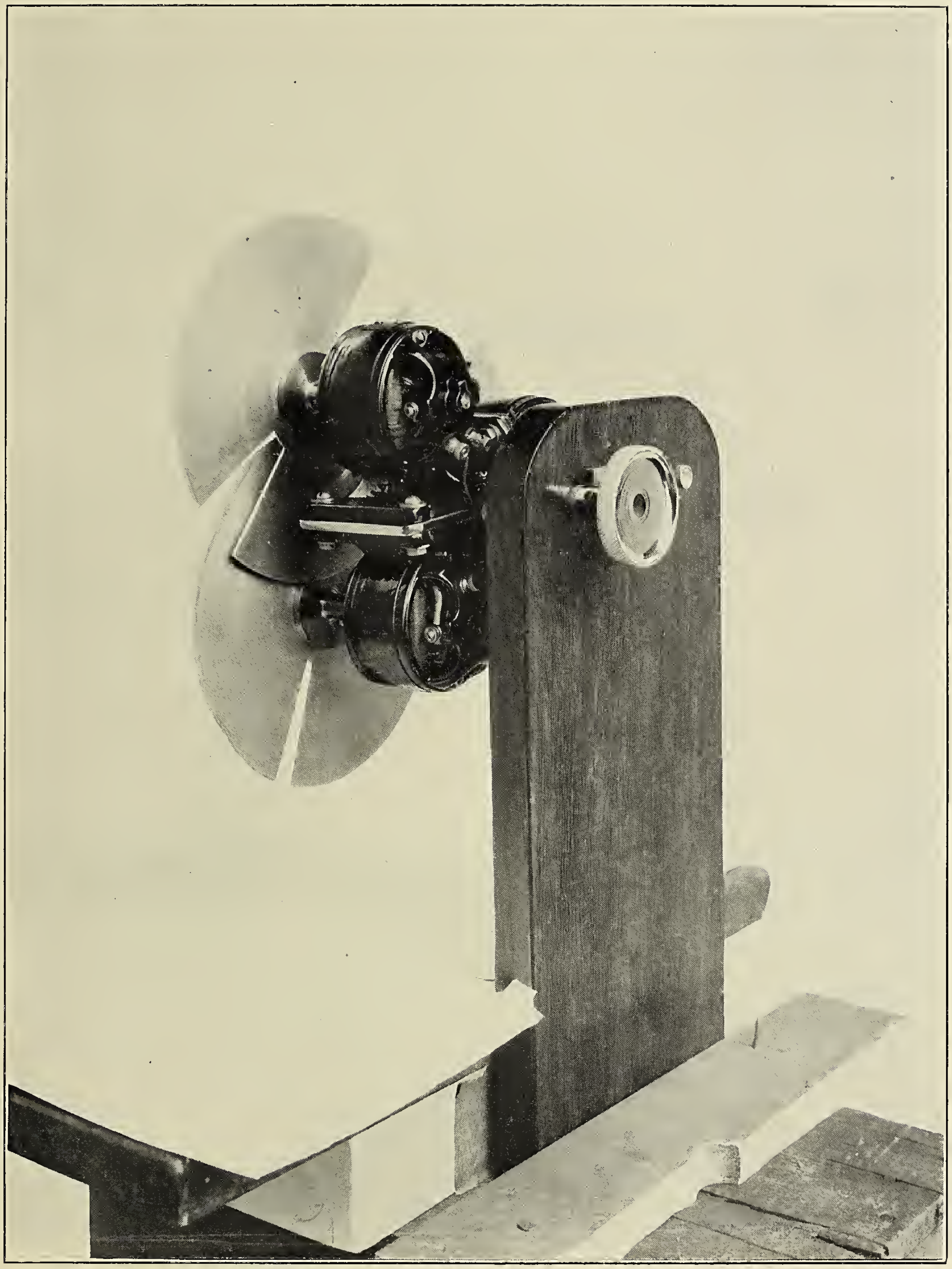
We are convinced that with these corrections we have been able to keep the Table Mountain pyranometry values mutually comparable from 1925 to the present time. We now maintain a system of frequent comparisons of the pyranometer with other instruments to prevent future discrepancies of a similar sort to those hitherto encountered. We again remind our readers, however, that in the short method developed first at the Chile stations it takes 20 per cent error of the pyranometer to produce 1 per cent error of the solar constant, so that the roughness of our corrections to pyranometry is not to be regarded as a serious source of error. As for the newer short method developed in 1930 to suit Table Mountain conditions, it is no more sensitive to pyranometer errors than the Montezuma method. We are now proposing to introduce a screen far in front of the instrument large enough to shade the whole aperture entirely from the sun.

ROTATING SECTORS

We have long been accustomed to regulate the intensity of radiation admitted to the spectrobolometer by means of a group of three rotating sectors as shown in Plate VIII. Electrical connections are so arranged that as soon as one of the sectors is pushed into the beam by the operator its electric driving motor starts, so that the sector rotates with great rapidity. Formerly we employed at Mount Wilson sectors whose apertures admitted radiation during the following fractions of the rotations: 0.343, 0.118, 0.0375. For the better observation of the weaker parts of the spectrums in the ultra-violet, and for the exact similarity of procedure at our several stations, we have now arranged that all our solar-constant observatories shall employ sectors which reduce approximately in the ratios: 0.594, 0.180, 0.0589. These sectors are introduced in the same places in the spectrum at all observing stations, and their effect is seen in Plates X and XI.

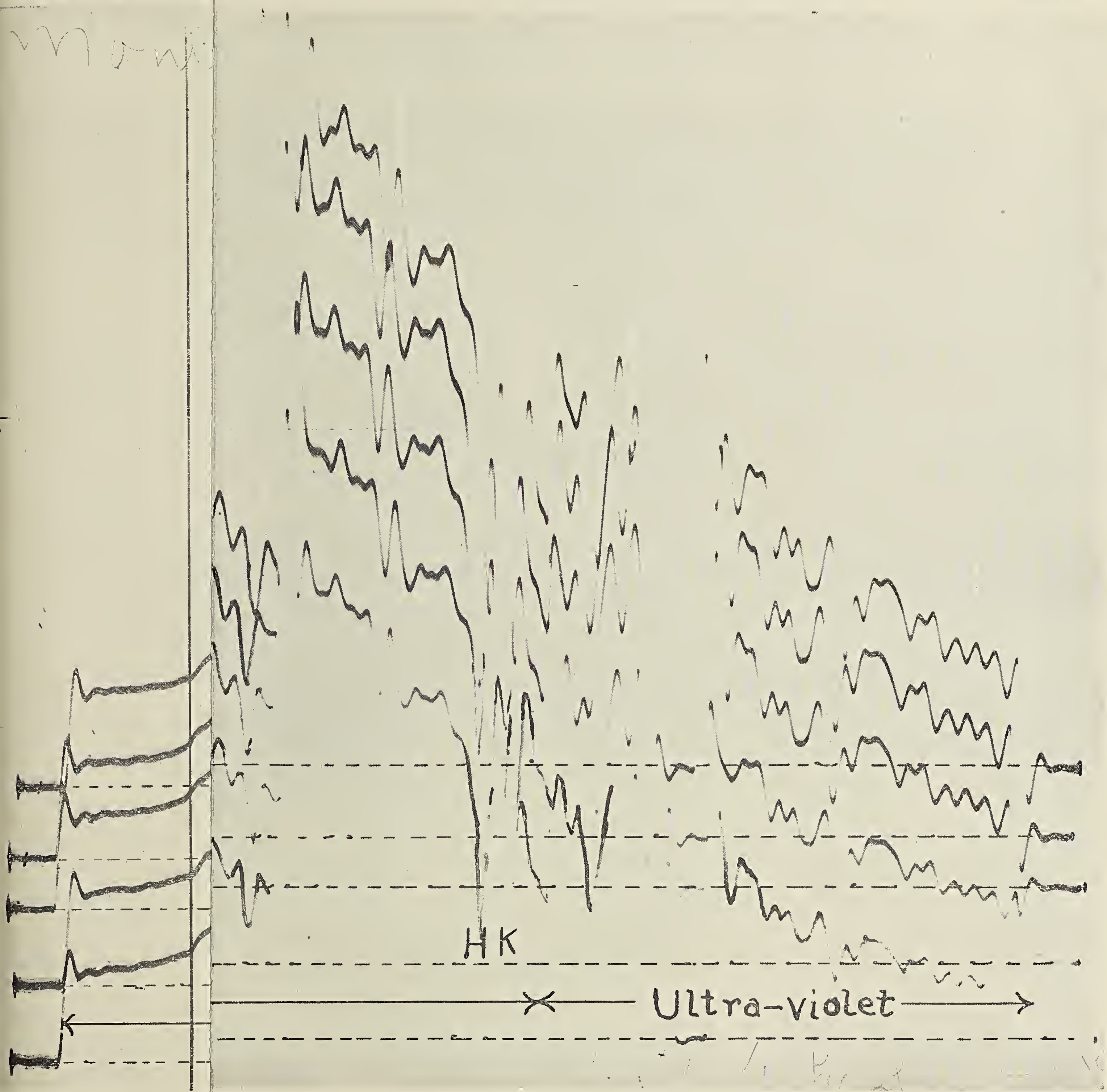
BOLOGRAPH READING DEVICE

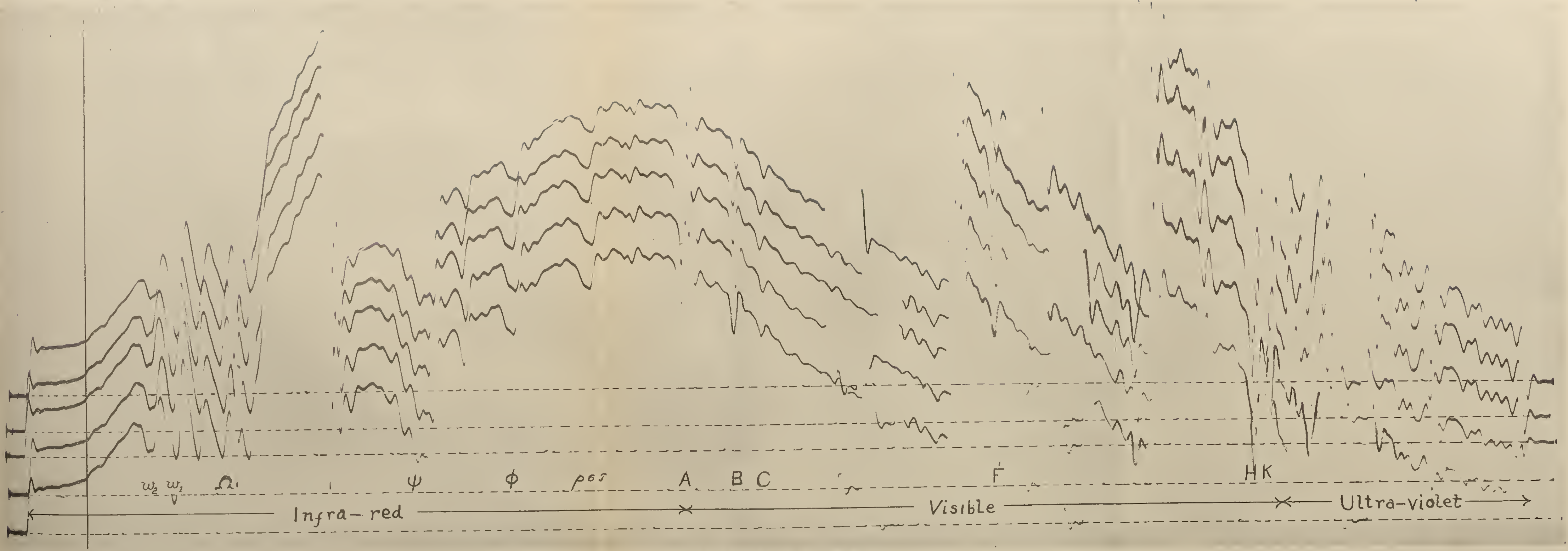
Although most of our present solar-constant determinations are made by what we call the "short method," we continue to carry through the determination by the fundamental method of Langley at each field station at frequent intervals. This requires the exact measurement of five bolographs at about 40 places each, in order to collect data for computing atmospheric transmission coefficients at numerous wave lengths. Formerly we were accustomed to draw smoothed curves in ink on the glass photographic record plates, and to measure the ordinates of the curves at equidistant intervals in abcissae. In the interest of greater accuracy we now select natural points on the photographic curves themselves and draw smoothed curves only over the great absorption bands of the infra-red spectrum. We have even reduced these infra-red smoothed curves in part to straight lines drawn between definitive identification marks. Throughout the ultra-violet and visible spectrum,



Rotating Sector Combination

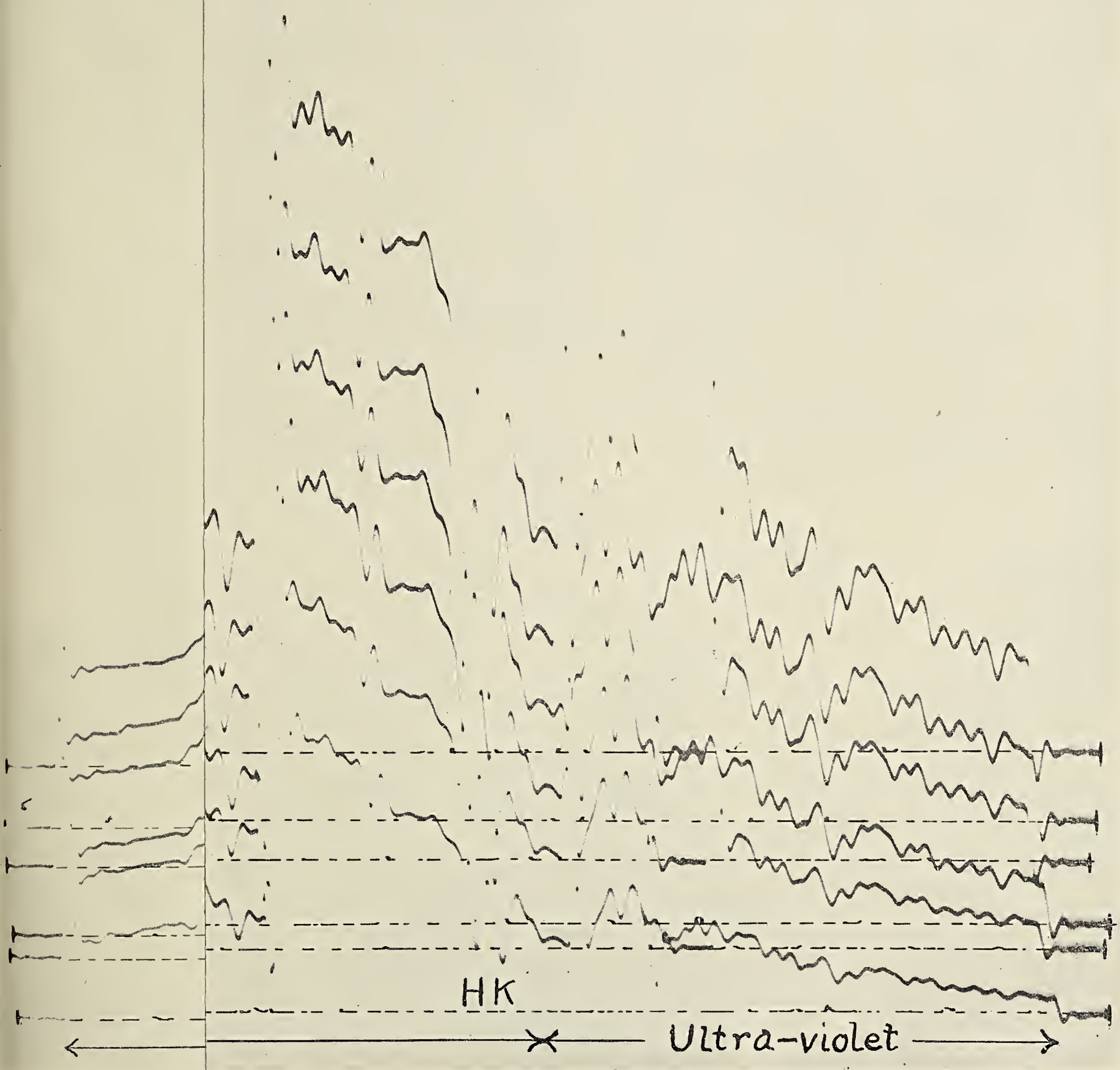
Bolograph Measuring Instrument

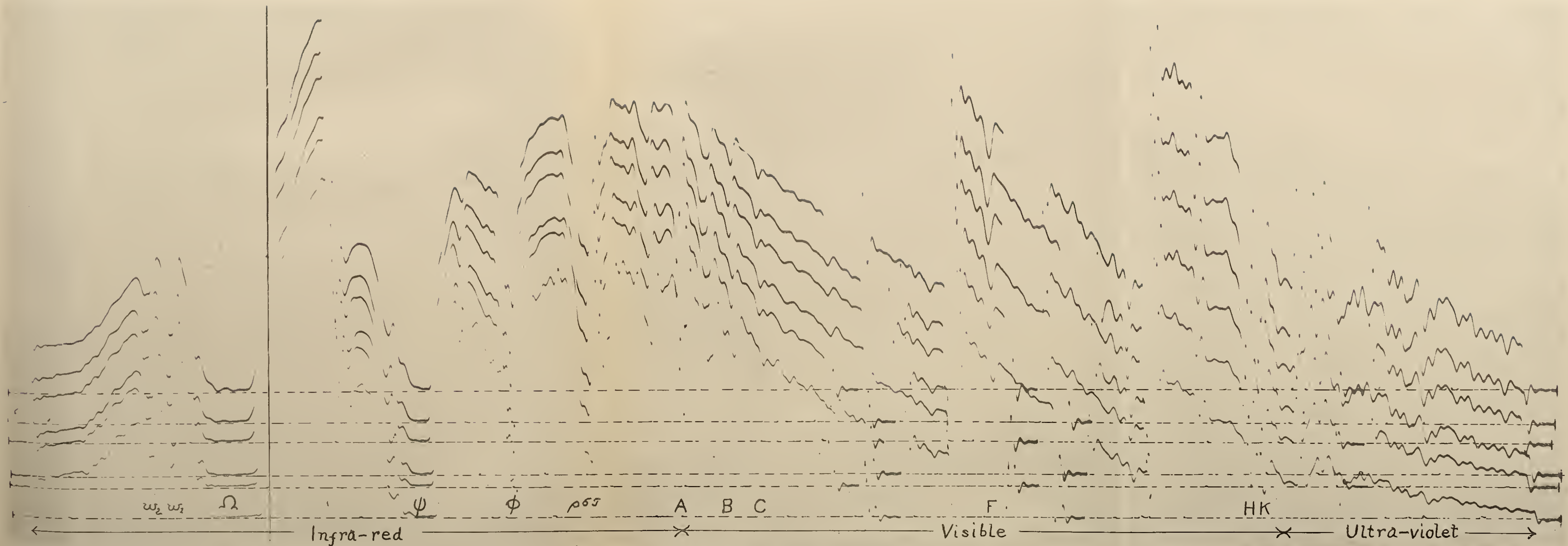

H K
Ultra-violet



GROUP OF BOLOGRAPHS. DRY ATMOSPHERE

White marks indicate smoothed curve and places where ordinates are measured.


HK
Ultra-violet



GROUP OF BOLOGRAPHS. MOIST ATMOSPHERE

White marks indicate smoothed curve and places where ordinates are measured.

and part of the infra-red, we now make readings at places corresponding to selected identification marks consisting of small depressions due to certain chosen Fraunhofer lines. These are chosen at intervals as nearly as possible duplicating the equally spaced positions formerly used when the smoothed curves were drawn. These details are indicated on Plates X and XI.

Although in this way we save time and also avoid personal error in drawing smoothed curves, the labor of measurement is in no way reduced thereby. To facilitate that work, we have designed a special rapid measuring machine, as shown in Plate IX. The inclined table is of translucent glass, on which rests the photographic plate to be measured. A steel T-shaped piece is displaceable by a screw in a direction parallel to the axis of ordinates of the plate, so that the transparent measuring scale which is carried by the blade of the T-square may have its zero adjusted to the base line of the bolograph which is being measured. Notches, corresponding in number and nearly in place to the positions where the plate is to be measured are cut on the back of the blade of the T-square. A clutch on the mounting of the transparent scale permits the operator to move the scale from notch to notch. At each notch the zero of the scale is adjusted by the screw, and then the ordinate of the selected identifying mark on the bolograph is read off to the tenth of a millimeter by direct observation and recorded.

RADIOMETER

As described in pages 59 to 64 of Volume IV of these Annals, it was proposed to measure the distribution of radiation in the spectra of the brighter stars by means of the vacuum bolometer. The apparatus was constructed as designed, including also a highly sensitive vacuum galvanometer, and was tested on several stars by Messrs. Abbot and Aldrich in the year 1922 at Mount Wilson, at the coudé focus of the 100-inch telescope. The results, published in Smithsonian Miscellaneous Collections, volume 74, number 7, proved disappointing. Energy was indeed recognized and measured in the spectra of several stars, but the apparatus was so much disturbed by drift and wiggle of the galvanometer that excessive difficulty and great uncertainty of measurement accompanied the operation of it. We were even led to suspect that the operation of electric cars in Pasadena, by producing surges on the power line to the mountain, affected our measurements on Mount Wilson.

The late Dr. E. F. Nichols offered to provide for us a sensitive radiometer on the principle of Sir William Crooks' discovery as developed into a measuring instrument by Nichols and perfected by Nichols and Tear. Such an instrument was furnished by Nichols and Tear and used by Doctor Abbot on Mount Wilson in 1923. The results of the observations on the spectra of 10 stars, including the sun, are published in the Astrophysical Journal, volume 60, 1924, and in Contributions from the Mount Wilson Observatory, No. 280. The operation of the instrument was very satisfactory, but it appeared that in order to secure results on a sufficiently large number of stars to establish the characteristics of the energy spectra of the different spectral classes, an instrument of about tenfold greater sensitiveness was needed.

In the year 1926, Doctor Abbot attempted to construct such a radiometer, employing house-flies' wings and a lighter mirror and support in place of the mica vanes and small but not excessively small frame and mirror used by Nichols and Tear. On trial, the instrument betrayed enormous sensitiveness when observing the star Betelgeuse, but being excessively damped by the air at the pressure necessary to give the radiometer effect, the deflections were very slow and indeterminate.

Doctor Anderson suggested the substitution of hydrogen for air as the radiometer gas. He suggested that the damping might thus be greatly reduced, but the radiometer effect nearly maintained.

We quote from the Astrophysical Journal of May, 1929, Abbot's account of the outcome of Anderson's suggestions:

In 1927 I made up two very light systems, one with 1.2 mm, the other with 2.0 mm between vane centers, each with vanes approximately 0.4 mm wide and 1.0 mm high. I made, also, bolometric strips which were used with them in the following manner. Three parallel test-tubes were joined by tubes, so that all three could be evacuated and filled together to any desired pressure with air or gas. In two tubes were sealed the radiometer systems, suspended on fine quartz fibers, and in the third were sealed the bolometer strips. Having been charged to a desired gas pressure, the instruments were exposed to a beam of light of nearly constant intensity. The deflection and the time of swing of each radiometer were observed when one of its vanes was illuminated. Also the deflection of a connected galvanometer was observed when one bolometer strip was exposed to the beam. By changing the pressure and the kind of gas, two series of measures were obtained in this manner, one for hydrogen, the other for air. These showed two kinds of results: From the bolometric deflections, the relative rise of temperature of blackened surfaces within the competing gases; and from the deflections of the suspended vanes, the comparative behavior of the two gases as regards radiometer effect and damping effect. Table I shows some of the results near optimum pressures.

Table I.—*Comparative results, August 5, 1927*

Instrument		Smaller system				Larger system				Bolometer
Pressure mm *Hg*	Gas	Time of first swing, seconds	Deflections of successive swings, mm			Time of first swing, seconds	Deflections of successive swings, mm			Deflection, mm
			1st	2d	3d		1st	2d	3d	
0.19	H_2	1. 25	92	52	38	3. 0	165	50	18	46. 5
0.19	Air	1. 6	82	22	8	4. 0	110	0	0	61. 3
0.26	H_2	1. 3	98	45	31	3. 1	125	35	7	36. 8
0.26	Air	2. 0	93	21	7	4. 2(?)	110	0	0	60. 4

For these light systems it thus appears that, although hydrogen is somewhat less efficient than air as regards rise of temperature of the blackened surface, the loss of efficiency is not so great as to offset the advantage of the very decided decrease in damping. It seemed evident that if the quartz fiber of a hydrogen-surrounded radiometer should be thinned until the time of swing matched that of a similar air-surrounded radiometer of 10-second single swing, the deflection of the hydrogen-surrounded instrument would be much the greater. Subsequent experiments demonstrated that for a system of the same dimensions as the smaller one, the deflections in hydrogen at 0.23-mm pressure for single swings between 0.5–2.5 seconds were almost exactly proportional to the square of the time of swing. At 2.5 seconds, the vane was far from critical damping. This leads to the expectation that such a system would show a decided gain in deflections from 2.5 up to 10 seconds single swing—probably not sixteenfold, corresponding to the square of the time of swing, but perhaps tenfold. * * *

In 1928, at the suggestion of Director W. S. Adams, of the Mount Wilson Observatory, a fused-quartz tube, about 4 cm in diameter, was made to my order by the General Electric Co. In its middle section it was figured within and without to concentric circular curvature by Mr. Kinney, of the optical shop of the observatory. This tube was exhausted to 0.0001-mm pressure through a liquid-air trap, washed out repeatedly with electrolytic hydrogen, filled to 0.23-mm pressure therewith, and sealed up with the suspended radiometer inclosed. In this work, which had to be done on Mount Wilson, I was greatly assisted by Mr. Pompeo, whose skill in working quartz and glass is very great.

Since the quartz tube was optically figured and of excellent clearness, it made no difference how the mirror and vanes were oriented. It was only necessary to support the tube from a ground joint in a brass ease in order that the whole tube containing the radiometer system might be rotated until the mirror looked out through the window of the brass case toward any desired part of the reading scale. A quartz window was employed opposite the vanes, so that, if desired, the experiments might be made with very short-wave ultra-violet, or very long-wave infra-red stellar radiation. In the experiments of 1928, however, a flint-glass prism was employed, and generally the spectral range was only from about 0.5 to about 2.5 microns.

A quartz fiber, so fine as to be handled with extreme difficulty, was used as a suspension. The vanes of the radiometer system were 0.4 mm wide and 1.0 mm tall, and but 1.2 mm between centers. Each vane had three parallel laminae of house-flies' wings, of which the front one was painted dead black, the two rear ones being unpainted. The laminae were separated by spaces of about 0.1 mm, in order that the communication of heat from front to back would be greatly impeded. The mirror, 0.9 by 1.0 mm and situated about 3 cm above the vanes, was made of microscope cover-glass which had been ground and polished to about half the usual thickness and platinized on both sides by sputtering. The whole system, including vanes, glass stem, and mirror, weighed 0.94 mg.

Some notion of the excessive fineness of the quartz fiber, 10 cm long, may be had from the fact that when suspended in full atmospheric air pressure, 44 complete turns of the top support were made before the suspended system began to rotate in response. The air, in other words, acted as if viscous, like tar, although the vanes were so small and near together that very slight force must suffice to rotate them.

The following are details relating to weights and moments of inertia of the radiometer parts. The weight of 22 flies' wings, approximating 200 sq. mm in area, was 1.7 mg. After blackening, eight flies' wings having an area of approximately 70 sq. mm weighed 3.1 mg. Hence the weights of the four fragments of unblackened flies' wings which were used were negligible compared to the two fragments of blackened wings. The moment of inertia of the fly-wing vanes as actually cut and mounted is 132×10^{-9} g. cm^2.

After grinding, polishing, and platinizing, the mirror glass weighed 0.20 mg per square millimeter. The moment of inertia of the mirror used, 0.9×1.0 mm is 121×10^{-9} g. cm^2. The glass cross-rod weighs 0.023 mg and its moment of inertia is 37×10^{-9} g. cm^2. Compared to these, the moments of inertia of the vertical glass stem and wax used are negligible.

Hence, the total amount of inertia is 290×10^{-9} g. cm^2, nearly equally divided between the vanes and the nondeflective parts.

The total weights are as follows:

	Mg
Vanes	0.035
Mirror	.180
Cross-rod	.023
Vertical	.700
Total	.938

The glass parts were cemented together with minute quantities of shellac from which all alcohol had been evaporated by heat and reduced pressure. The vanes and mirror were cemented on with minute quantities of beeswax. Since there was some doubt as to whether beeswax would evaporate sufficiently to contaminate the hydrogen within a moderate time, an area of 1,400 sq. mm of mica was coated with beeswax on August 24, 1926, and weighed after standing a half hour under a bell jar with phosphorus pentoxide. After a similar drying on October 30, the weight appeared unchanged, and on June 21, 1927, there appeared to be a loss of weight of 0.2 mg. Throughout this period the temperature of the beeswax considerably exceeded that to which it would be subjected on Mount Wilson. When the times, areas, and temperatures involved are taken into consideration, the evaporation appears to be negligible, even compared to the weight of hydrogen in the containing case.

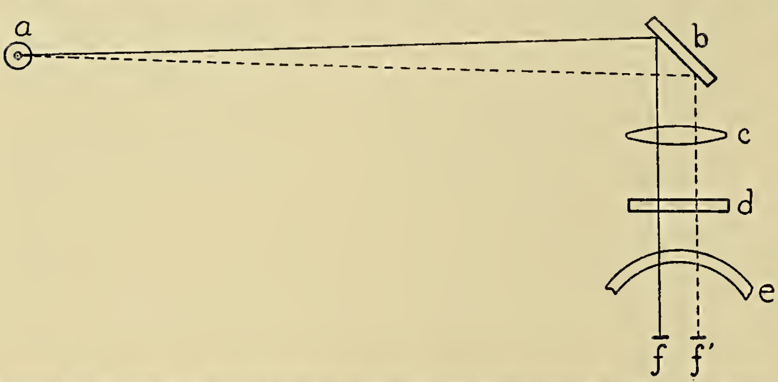


FIGURE 12.—Diagram of optical set-up for testing radiometer sensitivity: *a*, candle; *b*, silvered mirror; *c*, glass lens; *d*, quartz plates; *e*, quartz tube; *f*, *f'*, radiometric vanes

During the exhaustion and filling of the quartz tube, rough tests indicated that the system would have a single swing of about 12 seconds. But when the tube was inserted in its brass case it was astonishing to find that the time of single swing was only 0.5 second. When the apparatus was left overnight, the time of swing increased to nearly 2 seconds. After a week's rest it appeared again to be above 10 seconds. It was then found necessary, however, to remove the tube to clean finger marks from the quartz surfaces. On reassembling, it was found that the time of single swing had diminished to 1 second. On the assumption that electrical charge, due to friction, was the cause of the controlling field, sufficient water was introduced to saturate the air of the outer case. The apparatus was untouched for more than a week afterward before trying it for the first time on stellar spectra. But the time of swing rose only to 1.5 seconds. After a further interval of nearly three weeks before a second trial, the time of swing remained 1.5 seconds. I still think, however, that the cause of this unduly quick action is electrostatic, and hope that before another trial is made the instrument will recover its longer time of swing and high sensitiveness.

The following test, with the set-up shown in Figure 12, was made to measure the sensitiveness of the radiometer as actually used with a single swing of 1.5 seconds. The radiometer was exposed to rays from a candle, *a*, at 2.4 m distance, reflected at 45° by a silvered glass mirror, *b*, through a crown-glass lens, *c*, of 3-mm thickness and 3.7-sq. mm aperture, and thence through two quartz plates, *d*, each of 3-mm thickness, to focus on a radiometer vane, *f* or *f'*. Since this was only about two-thirds as tall as the candle-flame image, there was a large loss of radiation. Under these circumstances a deflection of 80 mm was produced on a scale at 40 cm distance when the image of the flame was shifted from one vane to the other, just as in actual practice with stellar spectra. During observations on stars, the scale distance was 6 m instead of 40 cm thus giving fifteenfold greater sensitiveness than during the tests. Had the desired time of single swing of 10 seconds or more been available, the sensitiveness would, I believe, have been further increased nearly twentyfold. A rough test made with the candle source on the only day when the time of swing exceeded 10 seconds showed a deflection on the scale at 40 cm which was evidently several times as great as the entire length of the 200-mm scale. Whether this increased sensitiveness would have produced a very great gain in accuracy of the results I am not prepared to say, for no doubt the accidental errors of reading would have increased with a longer time of swing and greater sensitiveness. * * *

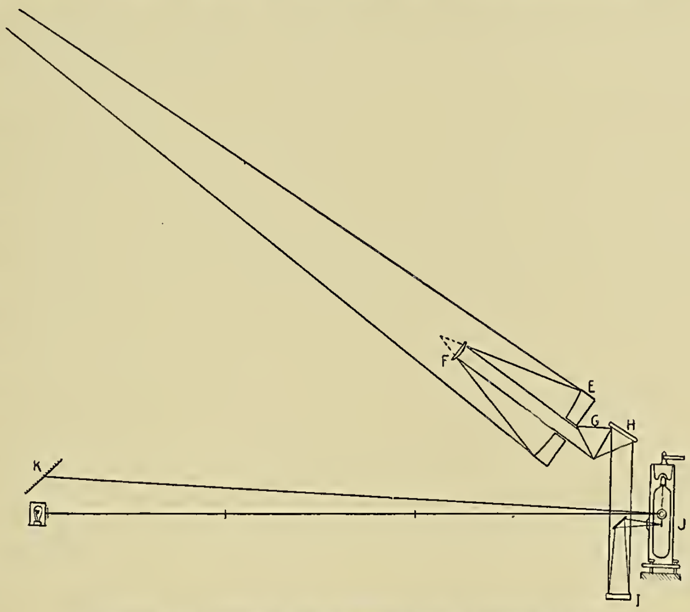


FIGURE 13.—Diagram of stellar spectral set-up, Mount Wilson

The success of the experiments depended on the means used for observing the deflections. These are indicated in Figure 14. A 100-watt incandescent lamp with ring-shaped filament sent a tiny ray through several diaphragms and through a long-focus lens to illuminate the mirror of the radiometer, about 5 m distant. Owing to the shape of the constant-temperature room, the beam, both in approaching and receding from the radiometer, had to be turned through 90° by small mirrors. The spot of light fell upon a long horizontal cylindric lens, 6 m distant from the radiometer, and beyond it, upon a ground glass, not marked in any way. A fairly bright blur of light, nearly circular in form and about 1 cm in diameter, was thus produced. Behind the ground glass was a little movable frame, operated at pleasure by a screw or by hand displacement, which carried opposite the spot of light a bit of cork cut so that when placed centrally it obscured all but a thin halo of light. Below the ground glass was a scale of equal parts ruled on the ground glass base side of a long 45° prism of glass, which could be illuminated from beneath by total reflection at the hypotenuse of the prism. A cross-wire, carried by the movable frame, indicated on the illuminated scale the number of whole turns of the screw corresponding to a given setting. A divided head of ground glass which could also be illuminated indicated the hundredths of a turn of the screw. As the pitch of the screw was 3 mm, the settings could readily be observed to 0.03 mm, and by estimation of tenths, to 0.003 mm, if desired.

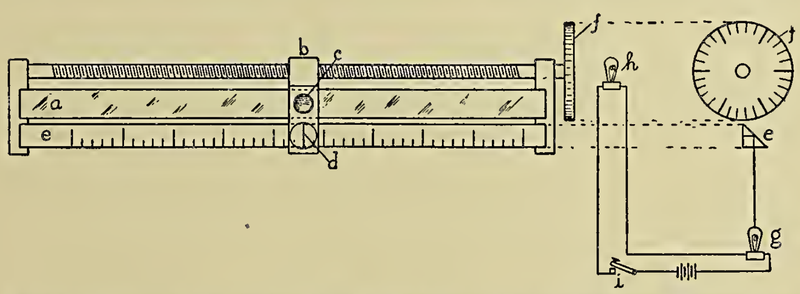


FIGURE 14.—Diagram of special scale for reading deflections: *a*, plain ground glass; *b*, sliding frame; *c*, cork occulter; *d*, cross hair; *e*, triangular glass scale of screw divisions; *f*, ground glass divided screw head; *g*, *h*, lamps for scales; *i*, switch.

The method of reading deflections will now be apparent. By a photometric comparison of the total light on the right and left of the occulting cork, the observer, working in almost total darkness, made the setting. Then by pressing a button the scales were momentarily illuminated and the accurate readings were made. As will appear from the tabular values, the average probable error of a single reading was only 0.06 mm, including not only the errors of a single setting but also those displacements produced by changes of transparency of the air, "boiling" of the star image, and unsteadiness of the radiometer.

With this instrument the distribution of energy in the spectra of 18 stars and 2 planets was observed in 1928, the faintest being of magnitude 3.8. Owing, as supposed, to the electrostatic charge above mentioned, the deflections were very small. In order to get satisfactory progress in this interesting field, still further improvement of the radiometer is needed.

Chapter III

METHODS OF OBSERVATION AND REDUCTION

Our main object is to determine the intensity of solar radiation outside our atmosphere at mean solar distance (usually called the "solar constant") and to measure the fluctuations of this quantity.

THE LONG METHOD

We gave the general principles and processes of application of the fundamental method of solar-constant determination in Volume II of these Annals, pages 13–19, 50–82. We epitomized and illustrated these processes in Volume III of the Annals, pages 21–30, and we noted various modifications and necessary corrections in pages 39–46. In Volume IV, pages 323–366, we gave experimental evidences tending to meet several criticisms of our application of this method of solar-constant determination.

We have noted in Chapter II of this present volume a change in the method of reading the ordinates of bolographs, whereby personal equation in marking smoothed curves on the plates is eliminated. Plates IX and X show the present treatment of the curves in this respect. We also noted in Chapter II the change in rotating sector ratios.

Another modification of our procedure relates to the corrections applied for portions of the spectrum not daily observed, lying respectively at the extremes of the ultra-violet and the infra-red spectrum. As this subject has been dealt with in full in a paper published in 1927 by Doctor Abbot, we quote as follows the pertinent passages:[1]

INFRA-RED CORRECTION

In the year 1922, at Mount Wilson, Messrs. L. B. Aldrich and C. G. Abbot employed a spectrobolometer with rock salt prism. They employed also an accessory spectroscope (often called a "sifting train") having a rock salt prism, in order to remove error arising from the stray light scattered from the most intense parts of the spectrum. With this combination they observed the intensity of infra-red solar radiation at different altitudes of the sun, down to a wave length of 11 microns.

[1] Gerland's Beiträge zur Geophysik, vol. 16, Heft 4, pp. 350–359, 1927.

The following table gives the unsmoothed results for the range of wave lengths from 2.4μ to 10.9μ, and for four different air masses. These values are given on the scale of deviation of a 60° rock salt prism.

TABLE 9.—*Extreme infra-red solar spectrum intensity*

Prismatic[1] deviation from "A"	Wave length microns	Air mass			
		4.30	3.61	2.79	2.00
250	10. 9	1. 9	2. 9	2. 4	3. 1
240	10. 7	0. 6	1. 3	2. 1	2. 1
230	10. 4	1. 7	2. 5	2. 7	2. 5
220	10. 1	1. 4	2. 5	2. 3	2. 3
210	9. 8	0. 6	0. 7	1. 4	1. 9
200	9. 5	0. 7	1. 7	1. 9	1. 9
190	9. 2	2. 5	2. 7	2. 8	3. 3
180	8. 9	3. 0	3. 7	3. 5	4. 2
170	8. 5	2. 0	3. 5	3. 4	4. 0
160	8. 1	0. 4	0. 4	0. 9	2. 4
150	7. 7	0. 0	0. 0	0. 0	0. 0
140	7. 2	0. 0	0. 0	0. 0	0. 0
130	6. 8	0. 0	0. 0	0. 0	0. 0
120	6. 3	0. 0	0. 4	0. 0	0. 5
110	5. 8	0. 0	0. 5	0. 3	1. 1
100	5. 3	9. 1	23. 2	21. 3	26. 5
90	4. 7	13. 1	7. 5	9. 9	15. 2
80	4. 0	29. 0	57. 8	68. 3	95. 4
70	3. 3	[2] 245. 4	[2] 250. 0	[2] 259. 4	[2] 307. 4
60	2. 4	22. 3	16. 3	19. 3	19. 3

[1] "A" signifies the great oxygen band of Fraunhofer's nomenclature.

[2] This value is adjusted so that in a total summation of the area under the energy curve it gives a fair value for the short, intense region between two absorption bands.

It is clear that the above values are very rough. Their uncertainty is due to the extreme difficulty of dealing with stray light in this feeble part of the spectrum. Nevertheless, for the purpose in view, which is merely to obtain approximately the corrections for infra-red regions of spectrum not observed, but which altogether contain only about 2 per cent of the sun's energy, it is believed that they are sufficiently good.

We make use of them as follows: Summing up the areas contained under the curves defined by the values in Table 9, we compute the ratios of their areas to the areas included beneath the energy curves, between rock salt prismatic deviations of +60′ and −11.5′ from the A line. These limits correspond to the region between places −5 and +19.5 in our ordinary readings[2] of ultra-violet glass prismatic bolographs, and to wave lengths 2.5 and 0.704 microns, respectively.

These ratios are as follows:

Extreme infra-red energy

Air mass	4. 30	3. 61	2. 79	2. 00
Centimeters precipitable water in the oblique beam	5. 33	4. 48	3. 46	2. 47
Percentage of areas	1. 74	1. 96	2. 10	2. 57

[2] These place numbers are proportional to prismatic deviation from the band ω_1.

The line "precipitable water" was gotten as follows: We first measured the areas included in the bands $\rho\sigma\tau$ and θ, upon the bolograph taken at air mass 2.0, with the rock salt prism. We then found a bolograph taken under standard conditions at Montezuma, Chile, for which the precipitable water was well known and for which these bands presented equal areas with the bands on the rock salt bolographs, in proportion to the total area between the bolographic places -5 and $+19.5$. On this evidence we assumed equality of precipitable water on the two occasions. For other air masses than 2.0, the quantity was increased proportionally to the air mass.

The data just given were then plotted, percentages of area against quantities of precipitable water. From the smooth curve of best fit, the following values were drawn off. All of them relate to the area included by the smooth energy curve, between the limits -5 and $+19.5$, corresponding to wave lengths 2.5 and 0.704 microns, respectively. By "smooth curve" we imply a bolograph in which the water-vapor bands in that region are filled up.

Infra-red correction ratios

Precipitable water, cm	0	1	2	3	4	5
Percentage of area	3.95	3.28	2.77	2.35	2.03	1.80

As the total area of the energy curve, as computed for outside the atmosphere, is almost exactly double the area included between -5 and $+19.5$, it follows that the infra-red correction outside the atmosphere, where precipitable water is zero, is now taken at almost exactly 2 per cent of the solar constant. In the work published in Volume IV of our Annals, all of it being prior to 1920, the infra-red correction outside the atmosphere, was regarded as 0.0055, so that a direct increase of 1.45 per cent has been introduced. This increase is to a great extent eliminated, however, by another consideration, to be mentioned after having considered the ultra-violet correction.

ULTRA-VIOLET CORRECTION

In our new determination of the ultra-violet correction we proceeded first from the assumption that the ultra-violet solar energy curve, if it were not for the very numerous Fraunhofer lines, would follow the form of the energy curve for the perfect radiator, or "black body," at 6,000° abs. C. In order to apply a correction for the absorption in the Fraunhofer lines, we measured on Rowland's photographic solar-spectrum map the total widths of spectrum, and total widths thereof occupied by Fraunhofer lines, between certain wave lengths. For such of these intervals of wave length as were included on our bolographic curves, we measured also the areas included beneath a curve drawn smoothly over the tops of the bands, and also the area included between the smooth curve and the jagged contours of the bands themselves. Taking the ratios of the band areas to the smooth curve areas, we compared these ratios with corresponding ratios of widths on Rowland's map. The comparison numbers were somewhat divergent, but gave a mean value of 0.72. We therefore regarded the lines photographed in Rowland's map as approximately 0.7 black in this spectral region. We used this relation to compute, as given in the final column of the following table, the percentage of radiation of the 6,000° black body given out by the sun in the ultra-violet.

Table 10.—*Line absorption data in the ultra-violet solar spectrum*

A	B	C	D	E	F	G	H	I
Wave length interval (microns)	Correspond-ing prismatic places	Rowland		Bolographic areas			Ratio, Rowland	1–0.7H
		Total width	Total line width	Smooth curve	Lines	Ratio		
		Cm	*Cm*				*Per cent*	*Per cent*
0.27 –0.30		100. 2	100. 2				100. 0	30. 0
.30 – .31		33. 4	18. 0				53. 9	62. 3
.31 – .32		33. 4	5. 0				15. 0	89. 5
.32 – .33		33. 4	4. 4				13. 2	90. 8
.33 – .342		38. 7	6. 4				16. 5	88. 7
.342– .350	48–46	25. 6	4. 8				18. 8	86. 8
.350– .360	46–44	32. 2	7. 0	69	9. 5	13. 8	21. 8	84. 7
.360– .371	44–42	35. 6	7. 4	105	13. 0	12. 5	20. 8	85. 4
.371– .385	42–40	44. 1	11. 8	148	30. 0	20. 3	26. 8	81. 2
.385– .397	40–38	44. 1	16. 0	192	44. 0	34. 1	36. 3	74. 6
.397– .413	38–36	54. 2	7. 2	198	12. 0	6. 1	13. 3	90. 7

$$\text{Mean}\frac{G}{H}=0.72$$

With the percentages in column I of the preceding Table 10, we computed, from the 6,000° black-body curve, a revised curve assumed to be the sun's energy curve as modified by Fraunhofer line absorption. Also we selected, from certain results representative of our mountain stations,[3] two sets of atmospheric transmission coefficients for various wave lengths, corresponding to very clear and to rather hazy conditions. These transmission coefficients we raised to the powers 1, 2, 3, 4, 5, corresponding to air masses within the usual range of our observations. These various data are as follows:

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[3] These coefficients of transmission naturally are much higher than those determined by Fabry and Buisson, because our stations lie at much higher altitudes than theirs. However, we did not employ our transmission coefficients without careful scrutiny, nor without diminishing them below our observed values in the ultra-violet. Fowle has computed, according to Rayleigh's theory, the following transmission coefficients for Montezuma, assuming the atmosphere to be made up of gaseous molecules, without dust or special absorbents:

Wave length, microns	0. 30	0. 36	0. 38	0. 41	0. 50
Computed transmission	. 45	. 67	. 74	. 80	. 91

It will be seen that the transmission values in Table 11 are taken a little lower than Fowle's computed ones.

Doctor Pettit has informed us that recent measurements of the atmospheric transmission coefficient at Mount Wilson, for the solar rays transmissible by thick silver deposits, for which the range of wave lengths is from 0.316 to 0.330 microns, yield the value 53 per cent. It will be seen that the values we have used in this wave length region are lower than Pettit's.

Table 11.—*Solar energy spectrum curve and atmospheric transmission*

Wave length, microns	Assumed energy of sun[1]	High transmission	Low transmission	Squares High	Squares Low	Cubes High	Cubes Low	Fourth powers High	Fourth powers Low	Fifth powers High	Fifth powers Low
		per cent	*per cent*								
0. 295	33	0. 20	0. 04	0. 04	0. 00	0. 01	0. 00	0. 00	0. 00	0. 00	0. 00
. 305	90	. 36	. 16	. 13	. 03	. 04	. 00	. 02	. 00	. 01	. 00
. 315	143	. 45	. 27	. 20	. 07	. 09	. 02	. 04	. 00	. 02	. 00
. 325	155	. 51	. 37	. 26	. 13	. 13	. 05	. 07	. 02	. 03	. 01
. 336	164	. 56	. 45	. 31	. 20	. 18	. 09	. 10	. 04	. 06	. 02
. 346	168	. 60	. 51	. 36	. 26	. 22	. 13	. 13	. 07	. 08	. 03
. 355	171	. 64	. 56	. 41	. 31	. 26	. 18	. 17	. 10	. 11	. 06
. 366	178	. 67	. 61	. 45	. 37	. 30	. 23	. 20	. 14	. 14	. 09
. 378	175	. 71	. 65	. 50	. 42	. 36	. 27	. 25	. 18	. 18	. 11
. 391	168	. 74	. 69	. 55	. 48	. 41	. 33	. 30	. 23	. 23	. 16
. 405	209	. 77	. 72	. 59	. 52	. 46	. 37	. 35	. 27	. 27	. 19
. 450	240	. 84	. 79	. 71	. 62	. 59	. 49	. 50	. 38	. 42	. 30
. 500	247	. 89	. 84	. 79	. 71	. 70	. 59	. 62	. 50	. 55	. 42
. 600	224	. 93	. 88	. 86	. 77	. 80	. 68	. 74	. 59	. 69	. 52
. 700	186	. 96	. 91	. 92	. 85	. 88	. 78	. 85	. 72	. 81	. 66

[1] Derived as just explained from the 6,000° curve, allowing for estimated Fraunhofer absorption.

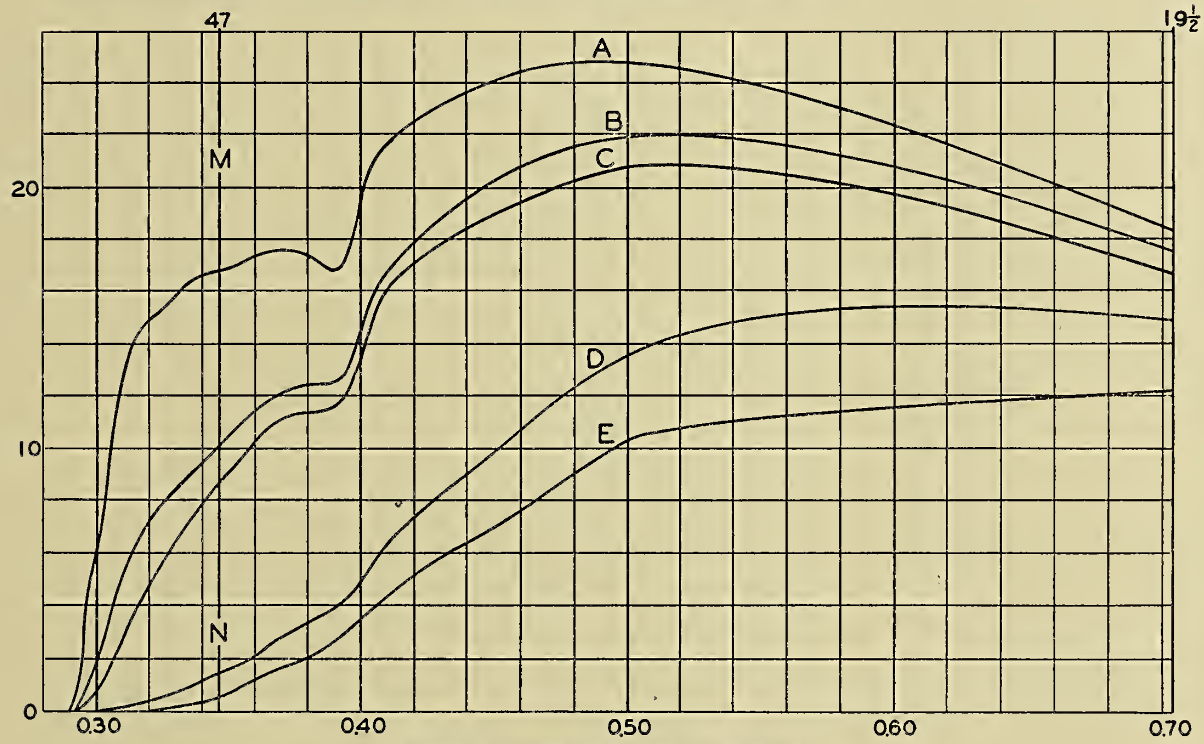

Figure 15.—Magnitude of ultra-violet correction.

By multiplying the values in the second column by those in each of the last 10 columns of Table 11, we obtained new spectral energy-curve forms, corresponding (as we assumed) to conditions at our mountain observatories, under atmospheres of different transparency, and for various air masses. Curves, shown in Figure 15 were drawn correspondingly. The vertical line *MN* divides the figure into two parts. To its right is found the area, as always measured upon the bolographs between places 47 and 19.5, corresponding, respectively, to wave lengths 0.346

and 0.704 microns. To its left lies the spectral region not usually observed by us, whose energy we desire to know, both outside the earth's atmosphere, and at various air masses at the stations themselves. Accordingly, the various areas of Figure 15 were measured by the planimeter, and the areas to the left of the line *MN* were expressed as percentages of the areas to the right. These percentages are given in the following table:

Ultra-violet correction percentages. First determination

Air mass	0	1	2	3	4	5
Clearer sky	9. 07	5. 05	2. 81	1. 61	1. 00	0. 61
Hazier sky	9. 07	3. 70	1. 65	0. 86	0. 49	0. 30

The results found above are obviously to a very large extent hypothetical. Is the sun a black body? Are the line absorptions as computed? It seemed best to check the determination by another computation. In this second instance, instead of basing the determination upon the 6,000° black-body curve, we employed the direct determinations of the solar spectral energy curve outside our atmosphere, as observed at Mount Wilson by Messrs. Aldrich and Abbot in the years 1920 and 1922.[4]

This energy curve we took as follows:

Observed solar energy curve. Arbitrary units

Wave length	0. 295	0. 305	0. 315	0. 325	0. 336	0. 346	0. 355	0. 360	0. 378	0. 391	0. 405	0. 450
Intensity	26	76	127	178	235	273	292	310	324	334	408	544
Wave length	0. 500	0. 600	0. 700	0. 800	0. 900	1. 000	1. 20	1. 40	1. 60	1. 80	2. 00	2. 20
Intensity	550	482	396	290	221	185	130	91	53	50	37	20

Treating these data as before, we arrived at the following results:

Ultra-violet correction percentages. Second determination

Air mass	0	1	2	3	4	5
Clearer sky	4. 71	2. 88	1. 61	0. 96	0. 58	0. 37
Hazier sky	4. 71	2. 14	1. 05	0. 53	0. 29	0. 20

Owing to the excessive difficulty and great uncertainty of our determinations of the form of the solar spectral energy curve in the ultra-violet region, and in deference to Fabry and Buisson's results from their ultra-violet solar investigations, as indicating larger intensities than we had observed, we determined to take the mean of the two sets of results, regarding them of equal weight.

Finding, also, that the range of atmospheric conditions given above did not quite cover our requirements, we extended the range a little by extrapolation, and came at last to the following table of corrections for ultra-violet rays not observed, beyond wave length 0.346 microns.

[4] Abbot, C. G., Fowle, F. E., and Aldrich, L. B., The distribution of energy in the spectra of the sun and stars. Smithsonian Miscellaneous Collections, vol. 74, no. 7, 1923.

Ultra-violet corrections. Determination of 1925

Transparency (place 36)	0.790	0.760	0.730
Air mass	Percentage corrections [1]		
0	6.88	6.88	6.88
1	3.90	3.39	2.90
2	2.22	1.79	1.36
3	1.28	0.96	0.64
4	0.73	0.56	0.38
5	0.45	0.33	0.21

[1] These percentages relate to the bolographic area between our places 47 and 19.5, corresponding, respectively, to wave lengths 0.346 and 0.704 microns.

The observer enters this table by first roughly measuring (from bolographs of the day in question) the transmission coefficient at place 36 (wave length 0.413μ). This value he compares with the "transparency," and selects the appropriate column, or interpolates between columns.

Formerly, as stated in Volume III of the Annals, we regarded the ultra-violet correction outside the atmosphere as 1.58 per cent of the solar constant. Inasmuch as the energy-curve area, 47 to 19.5, embraces about half of the whole area outside the atmosphere, it is clear that we now estimate the correction at about 3.44 per cent, and have now raised the ultra-violet correction by about 1.86 per cent of the solar constant above our former estimate of it. As we have said, the infra-red correction also is raised by 1.45 per cent of the solar constant, making a total change, acting directly to increase our values, of 3.31 per cent. This, however, is largely offset.

There is an indirect compensation which almost exactly eliminates the direct increase just explained. Even more radical alterations than those described above, in the supposed form of the solar-energy curve, have been made negligible by the same influence, which we are about to examine. To illustrate: Many years ago we used for a time a great flint-glass prism which cut off all solar rays in the ultra-violet beyond wave length 0.387μ. In the year 1911 we tested the effect of this gross error[5] by comparing solar-constant values for six different days, as computed with and without the ultra-violet region beyond 0.387μ. The results were as follows:

Effect on solar constant of error in form of energy curve

	June 20	July 11	July 13	July 14	Aug. 11	Sept. 2	Mean
1909 Ratio	1.005	0.992	1.020	1.004	1.007	0.996	1.004

Thus the two sets of computations differed from each other by only 0.4 per cent in the mean, and indicated no certain alteration at all, notwithstanding wide differences in the original data. The fact is that such shortcomings of observation as these encounter a procedure tending to correct them. It is as follows:

On every day of solar-constant determination by the fundamental method of Langley, we read the pyrheliometers simultaneously with taking the bolographs. We compared the total areas included beneath the bolographic curves with the pyrheliometer readings taken at the corresponding times. The quotients were apt to differ more or less through the day. We deter-

[5] See Astrophysical Journal, vol. 33, p. 192, 1911.

mined, just as Langley did over 40 years ago, correcting factors suitable to reduce all the bolographic areas to the scale of the pyrheliometer. Thus we changed all the observed ordinates of each bolograph by equal fractional amounts, corresponding to the pyrheliometer correction. Thus the areas included by the corrected bolographs thereby become exactly proportional to the pyrheliometer values.

Formerly, in our earliest Mount Wilson work of 1905 to 1909, the pyrheliometric correcting factors ranged over 10 per cent. They acted in the sense tending to raise the solar constant. Now they seldom range over 1.5 per cent, and act as often negatively as positively. They have, in fact, grown decidedly smaller, with the introduction of our new infra-red and ultra-violet corrections, in the year 1925. This recent change of correcting factors, in the sense tending to diminish solar-constant values, so nearly counterbalances the direct increase of 3.31 per cent above mentioned, that in the mean of over 100 days of observation recently re-reduced, in which the new corrections were for the first time employed, the new values exceeded the old by only 0.6 per cent. Thus, while admitting Kron's criticism[6] as to the inadequacy of our former estimates, their effect on the solar constant seems to have been nearly negligible.

From this lengthy discussion, readers will perceive that our knowledge of the solar spectrum within and without the atmosphere, beyond visible wave lengths in the ultra-violet, and beyond 2.4 microns in the infra-red, is not altogether satisfactory. Hence, even our newest corrections for unobserved infra-red and ultra-violet rays may be somewhat in error. Nevertheless, as we have demonstrated, these unknown inperfections are so exactly compensated by an indirect correction as to produce very small influence indeed on the absolute value of the solar constant.

To avoid repetition we shall postpone the discussion of statistical and special corrections of solar-constant values as dependent on the ozone and humidity of the atmosphere until we have discussed the short methods of solar-constant determination.

THE SHORT METHODS

In Volume IV of these Annals, pages 79 to 84, we described a method of estimating approximately the transmission coefficients of the atmosphere at all wave lengths in terms of the measurement of the intensity of total scattered sky radiation coming from a limited area near the sun. Inasmuch as the measurement of sky brightness can be completed in less than 10 minutes, this new procedure avoids the errors incident to changes of transparency of the sky, which are apt to occur at the best of stations during a period of several hours such as the fundamental method requires. We were able also by this method to make and fully reduce as many as three or four independent determinations of the solar constant in one day with less work than that required to make and reduce a single one by the long method.

Additional experience has led to further improvements and abbreviations of the new method. In an abbreviated form it is now in constant use at our field station at Montezuma, and has been extensively tested at Table Mountain and Mount Brukkaros. The method is empirical and therefore it is not greatly surprising that the different atmospheric conditions at these latter stations have led to modifications which will be described below. To make clear the nature of the

[6] Kron, E., Vierteljahrschrift der Astronomischen Gesellschaft, vol. 49, p. 53, 1914.

principal change made at Montezuma let us recall that the "short method" at its inception was merely a device to escape the necessity of taking a series of bolographs at different air masses for the purpose of determining atmospheric transmission coefficients at numerous wave lengths. Determining approximately these atmospheric transmission coefficients by the short method as the result of an easy measurement of the brightness of the sky, we proceeded on from that point just as if we were working the long method. That is to say, we measured the area of a certain bolograph; allowed for losses in the apparatus; and computed from the ordinates of the smooth curve what this area would become if observed outside the atmosphere. Such a computation was easily made, knowing the transmission coefficients and the air mass of the observation. The ratio $\frac{a}{b}$ of the areas (a as computed outside and b as observed inside the atmosphere) was used as a multiplier to determine what the pyrheliometer would have observed as the total solar radiation if it had been used on the moon, instead of having actually been read on the earth's surface at the air mass in question. In this way, although we avoided the tedious determination of atmospheric transmission coefficients, we were still required to make the logarithmic computation involved in determining the form and area of the bolograph as it would be outside the atmosphere.

Our new abbreviation consists in eliminating this last-mentioned individual computation by computing certain tables once and for all. This may be done because exact knowledge of the form of the solar energy curve is not essential. For instance, it makes so small a difference as to be of little consequence in the determination of the solar constant whether the estimations of the relative losses of energy of different wave lengths in the bolographic optical train are correctly determined. In short, it makes little difference if they, in a moderate degree, unfairly deplete one part of the spectrum as against others. This statement may be confirmed by referring to a previous page, where the results of computing solar constants with different optical transmission data are compared. By analogy it follows that only an inappreciable change of result by the short method would occur if, instead of using the ordinates of the smoothed energy curve actually observed on a given occasion, we should employ the average ordinates of a number of bolographs previously taken at the same air mass. In that case, to be sure, the form of the bolograph outside the atmosphere, as computed, would vary according to the transmission coefficients determined for the day in question, and would no longer be truly representative of the sun's energy-spectrum distribution in free space. Yet the ratio of the area of this inexact curve to the area of the adopted average curve would be almost identically the same as that of the area of the true curve to that of the bolograph observed on the day in question.

Proceeding with this idea, we determined average curves corresponding to the air masses 1.5, 2.0, 2.5, 3.0. We computed what each would become outside the atmosphere if operated upon by the system of atmospheric transmission coefficients proper to a certain value of the "function" of sky brightness and atmospheric humidity. Having made these computations for selected "function" values covering the entire expected range of conditions, we plotted these values on a sufficient scale, and finally we reduced the plots to tabular form. Thus we became enabled to read off from the table the area of the computed curve outside the atmosphere corresponding to the average curve inside the atmosphere under varying conditions of transparency, and to do this for any given day of observation. It only remained: (*a*) To subtract from the area of the selected inside curve the areas appropriate to the absorption bands of oxygen and water vapor for the time of observation; (*b*) to compute the ratio of the outside area to this corrected inside area; and (*c*) to multiply the ratio by the pyrheliometer value in calories.

With the new tables the computation of the solar constant has practically reduced itself to the reduction of the pyrheliometry, the determination of the air masses, and the measurement of the areas of the absorption bands of oxygen and water vapor. The reader will perceive that for the new short method the infra-red parts of the bolograph, wherein these water-vapor absorption bands occur, appear to be the only ones which any longer need observation. Yet we have continued to observe the usual range of spectrum from 0.34μ to 2.5μ because the results may be reduced by the long method, if there should be occasion on account of peculiar conditions. It is fortunate that we have done so, because the experience of recent years shows that these visible and ultra-violet regions have important uses for determinations of ozone and atmospheric transparency.

We have tested the new "short method" against the earlier "short method" for identical days and find, as was expected, that the two give identical results.

SUMMARY OF APPLICATION OF THE SHORT METHOD OF SOLAR-CONSTANT DETERMINATION IN USE AT MONTEZUMA

By function in the next following pages is meant:

$$F = \frac{Pn \times A}{Py}$$

Where

Pn = pyranometer reading in calories

Py = pyrheliometer in calories

A = area of ψ[7] in mm^2

The resulting function, if not already at one of the standard air masses, is to be reduced to it (i. e., 1.5, 2.0, 2.5, or 3.0) by means of Table A3.[8]

[7] The infra-red water-vapor band at wave length 1.1 microns is called ψ.

[8] The references to Tables A1 to A8, given on this and immediately following pages, relate to manuscript tables used at the observing stations. They are not here reproduced.

The area of ψ in the formula is read directly from the plate in sq. mm and divided by the observed ordinate at place 7.[9] Also as a check, the area of ψ is found from Tables A1 and A2.

With the values of the function (F) just found, and the air mass observed at 22[10] (not at the standard air mass [1.5, 2.0, 2.5, or 3.0] to which the F has been reduced) enter Table A4. This table has 12 sections and its arguments are F and the observed air mass, m. Take the section wherein the F is nearest the middle of the table. Interpolate for both arguments getting what may be called the "value of the area outside the atmosphere." Call this a_o. This includes both the ultra-violet and infra-red additions.

At the bottom of the corresponding page in Table A4 will be found a part of the "area inside the atmosphere," called a_i.

To this must be added the ultra-violet correction ($=u.\ v.$) and the infra-red correction ($=i.\ r.$) and from it is to be subtracted the water-vapor band area (H_2O bands) and also the areas of those bands which vary directly with the air mass (m bands).

The ultra-violet addition should be obtained from Table A5, interpolating for F and m. This table is in 12 sections like Table A4, and the corresponding section is to be used. For example: If A4 (2.0b) was used for a_o, then use A5 (2.0b) for $u.\ v.$

The infra-red addition should be obtained from Table A6, also in sections, and a similar remark as for $u.\ v.$ applies here.

The water-vapor band subtraction is taken from Tables A7a, A7b, and A7c, and separate reductions made from each.

The air mass subtraction is taken from Table A8, using m for place 22.

Next perform the operation:

$$a_i + u.\ v. + i.\ r. - H_2O \text{ bands} - m \text{ bands}$$

Next perform the operation:

$$\frac{a_o}{a_i + u.\ v. + i.\ r. - H_2O \text{ bands} - m \text{ bands}}$$

Next multiply the result of this latter operation by the phyrheliometer reading corresponding to $m=22$.

Next multiply by the pyrheliometer factor to reduce to calories.

Next multiply by the square of the earth's radius vector to reduce to the earth's mean solar distance.

The result is the preliminary solar-constant value. It becomes definitive when small statistically-derived corrections are added, as described later.

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[9] Place measured in centimeters from the band ω_1.

[10] Place in spectrum 22 cm from ω_1.

In illustration of actual computations by this method, we give the numerical application for Montezuma on June 29, 1930.

TABLE 12.—*Example of short-method reduction at Montezuma, June 29, 1930. Adopted solar constant, 1.944 satisfactory*

Time of start	$7^h\ 53^m$	$8^h\ 15^m$	$8^h\ 36^m$	$8^h\ 54^m$	$9^h\ 06^m$
Air mass, place 15	3. 01	2. 53	2. 21	2. 01	1. 91
Air mass, place 22	2. 98	2. 51	2. 20	2. 00	1. 90
Pyrheliometer at 22	3. 819	3. 943	4. 060	4. 139	4. 168
ρ/ρ smooth curve	. 768	. 747	. 764	. 780	. 784
φ/φ smooth curve	. 684	. 644	. 676	. 698	. 698
Function (a)	454	429	384	346	337
Function (b)	449	445	383	342	340
Function through measured area	476	468	393	354	355
Function mean	460	447	387	347	344
Function at standard air mass	463	446	355	347	362
A Area outside atmosphere	64, 020	64, 143	64, 515	63, 523	63, 108
Area inside atmosphere	50, 445	51, 698	52, 860	52, 860	52, 860
u. v. correction	234	311	400	445	469
i. r. correction	1, 174	1, 166	1, 175	1, 188	1, 189
B Corrected area	51, 853	53, 175	54, 435	54, 493	54, 518
Water-vapor bands (a)	3, 850	3, 966	3, 883	3, 734	3, 650
Water-vapor bands (b)	3, 804	4, 112	3, 868	3, 682	3, 682
Water-vapor bands (c)	4, 080	4, 400	4, 010	3, 856	3, 901
Other bands	599	556	523	504	492
C { Total bands (a)	4, 449	4, 522	4, 406	4, 238	4, 142
C { Total bands (b)	4, 403	4, 668	4, 391	4, 186	4, 174
C { Total bands (c)	4, 679	4, 956	4, 533	4, 360	4, 393
B—C { Final inside area (a)	47, 404	48, 653	50, 029	50, 255	50, 376
B—C { Final inside area (b)	47, 450	48, 507	50, 044	50, 307	50, 344
B—C { Final inside area (c)	47, 174	48, 219	49, 902	50, 133	50, 125
Solar constant [1] (a)	1. 935	1. 949	1. 965	1. 962	1. 959
Solar constant [1] (b)	1. 932	1. 955	1. 963	1. 961	1. 961
Solar constant [1] (c)	1. 944	1. 967	1. 969	1. 967	1. 968
Mean solar constant	1. 937	1. 957	1. 966	1. 963	1. 963
Statistical correction	—. 010	—. 014	—. 017	—. 017	—. 017
Corrected solar constant	1. 927	1. 943	1. 949	1. 946	1. 946

[1] Solar constant $=\text{Pyrh.}\times\frac{A}{B-C}\times\text{Pyrh. constant}\times\left(\frac{\text{solar distance}}{\text{mean solar distance}}\right)^2$.

MODIFIED SHORT METHOD EMPLOYED AT TABLE MOUNTAIN [11]

Although we did our best to adapt the short method used so successfully at Montezuma to Table Mountain observations, it proved a failure. Widely ranging discrepancies occurred, especially on very hazy days. Although when finally reduced in the best manner the monthly mean values at Table Mountain seemed fairly good, the daily values showed highly improbable ranges. We were led to devise a new procedure which, as it greatly reduced the average range of daily values and rescued

[11] This method has also been adapted to the observations from Mount Brukkaros.

many days which before seemed wholly valueless, we have now adopted for Table Mountain. To understand its *rationale* consider the following discussion:

If the atmospheric transparency remained unchanged day after day, the variation of the sun would proclaim itself in the observations without difficulty. Three factors principally alter the atmospheric transparency from day to day. These are ozone (which we shall discuss at a later page), humidity, and dustiness. Our procedure to correct for changes of humidity and dustiness is as follows:

If the atmosphere were tranquil, and neither cleansing rains, polluting fires, high winds, nor other disturbances occurred to alter its dustiness, then the sky brightness near the sun, as measured daily with the pyranometer, would have a certain normal value associated with the prevailing humidity. The greater the humidity, the brighter would be the "normal" sky, at least up to certain limits. Our first care was to determine the march of "normal pyranometry" at Table Mountain.

For this purpose we collected all of the observations made at air mass 2.0 from 1925 to 1930. These exceeded 1,000 days in number. We arranged them in many groups, each group having nearly constant values of "precipitable water," and we reduced the correspond-

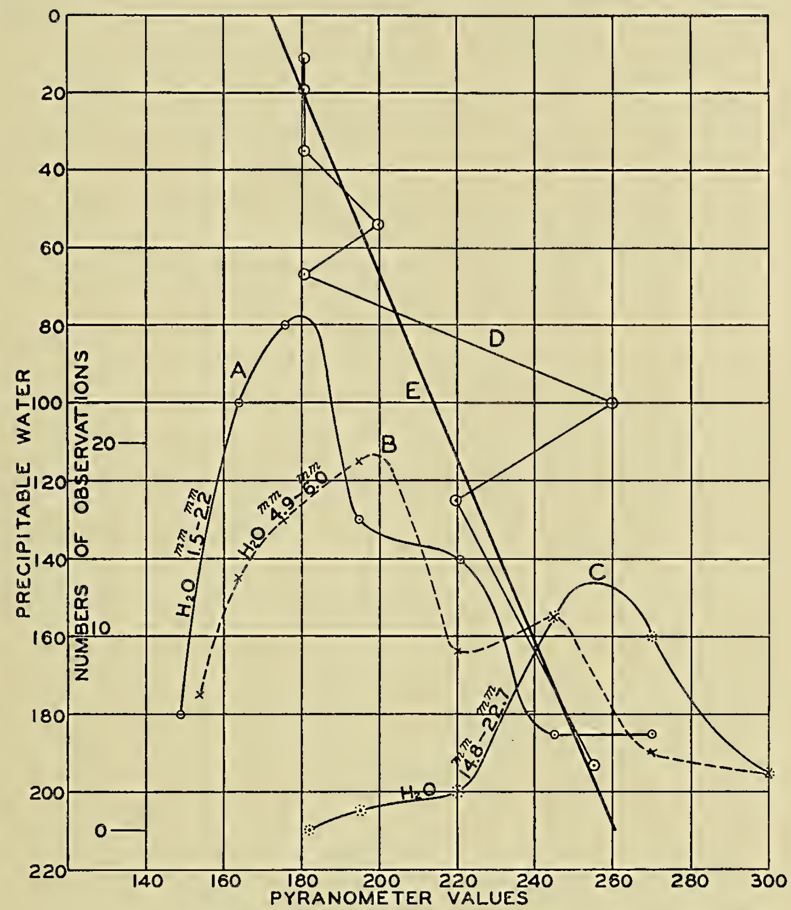

FIGURE 16.—Normal pyranometry. Table Mountain.

ing pyranometer values to mean solar distance in each group. Having done this we counted the numbers of days in each group when the pyranometer values lay between certain rather narrow limits. The widths of the ranges in limits we chose proportionally to the average corresponding pyranometry. These numbers of days we plotted as ordinates against the mean pyranometry of the groups of abscissae. Such plots are shown as *A*, *B*, and *C* in Figure 16. The plots plainly indicate that the maximum frequency occurs for pyranometry 181, 200, and 245 in these groups, respectively.

From the entire number of data we found that the curve of maximum frequency is as shown at *D* in Figure 16, and seems to be sufficiently well represented by the straight line E drawn there. This we regard as the line of "normal pyranometry" for air mass 2.0. A departure of any observed value from the indication of the line of normal pyranometry we term the "excess." It may have any value from −60 to +150 or even much more on very hazy days. These latter, however, we find too unsatisfactory to retain in the record.

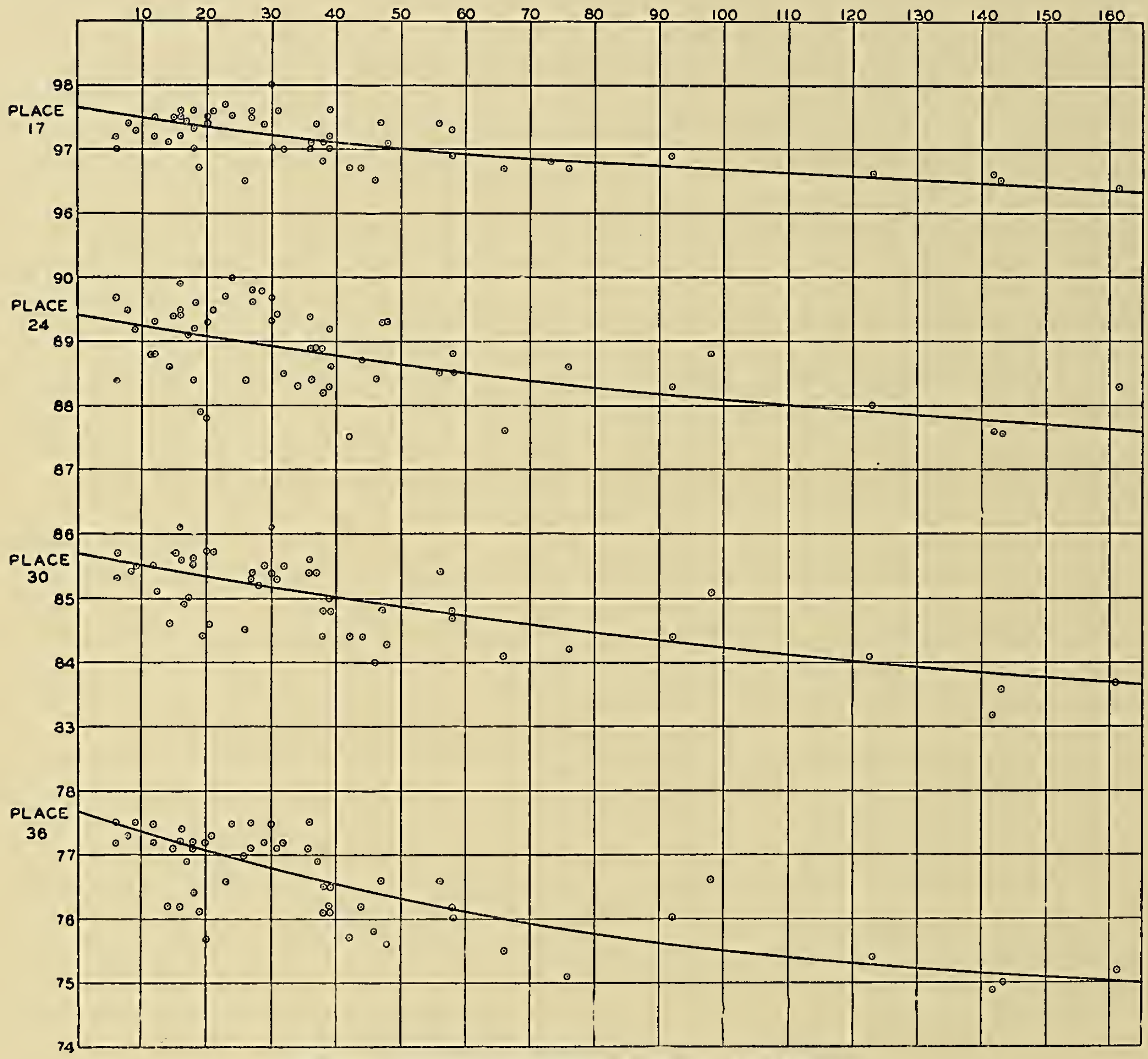

FIGURE 17.—Atmospheric transmission and humidity. Table Mountain.

Our next care was to discover the march of atmospheric transmission coefficients at selected places in the spectrum on days of normal pyranometry. The transparency decreases with increasing values of the precipitable water. We selected all available long-method days of satisfactory character for which the pyranometry at $m=2.0$ fell close to the line of normal pyranometry. For these days we plotted the observed coefficients of atmospheric transmission at spectrum places 36, 32, 30, 28, 24, 20, 17, and 11 against the value at $m=2.0$ of the precipitable water of the day. Sample curves of transparency for days of normal pyranometry are shown in Figure 17.

The next step was to determine the departures of atmospheric transmission coefficients from these curves when other than normal pyranometry prevailed. For this purpose we selected numerous satisfactory long-method days in which a wide range of precipitable water and of pyranometry at $m=2.0$ was presented. These we arranged in groups of rather narrow ranges of precipitable water. In each group, by aid of curves like Figure 17, we reduced the values of atmospheric transmission at the selected spectrum places to what they would have been if the precipitable water on each day had been at the mean value of the group. This done, we plotted "excess pyranometry" as abscissae against departures of atmospheric transmission from curves such as those of Figure 17 as ordinates. Such plots are shown in Figure 18.

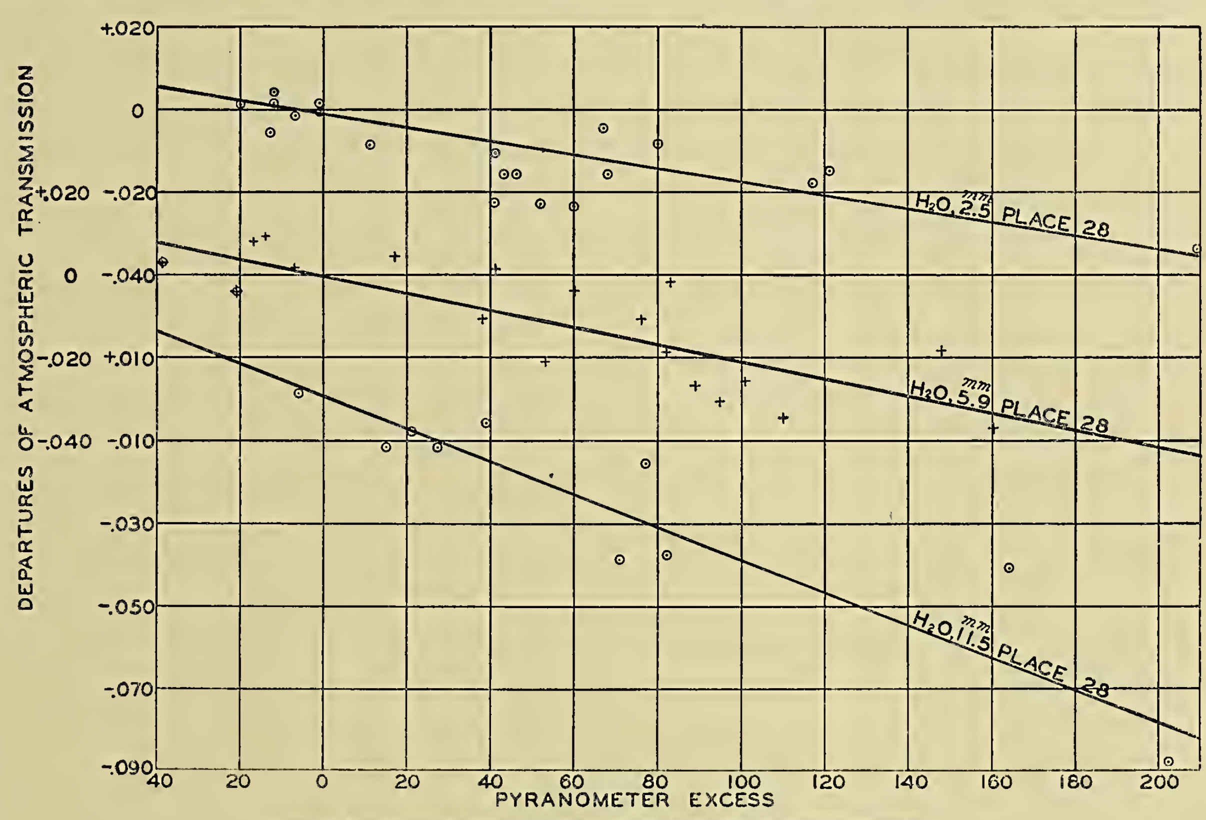

FIGURE 18.—Atmospheric transmission. Its dependence on pyranometry excess.

Not all of these plots were very satisfactory; yet from a consideration of them all we worked out a reasonably good table of corrections to the atmospheric transmission for normal pyranometry, depending on the precipitable water and the "excess." These results, if amplified to cover all spectrum places, might have enabled us to compute solar-constant values by the process originally used in the short method at Calama in the year 1919. But we wished to abridge the method.

The reader will recall that our short method, as still used at Montezuma, and for a long time used at Mount Harqua Hala and at Table Mountain, depends on the following implicit assumption. Corresponding to a given value of the "function" there exists a single series of values of atmospheric transmission coefficients for all the spectrum places proper to any day when that value of the "function" prevails. Furthermore, in our briefest short method, we had worked out for each of these three stations a large set of tables adapted to yield the area of a bolograph outside the atmosphere corresponding to every expected value of the "function." Accordingly if we could determine the value of this old "function" corresponding to any observed precipitable water and pyranometer excess, then the great computed table would again be available to us for determining the solar constant.

In short, we found it to be a fact that all of the selected spectrum places referred to above united, with only minor discrepancies, to point out proper values of the old "function" for which the series of values of atmospheric transmission coefficients were closely the same as those actually computed by the aid of our new table of precipitable water, pyranometer excess, and departures of transparency from that for normal pyranometry. We found, indeed, that to select a proper value of the "function" we had only to consider the indications at spectrum place 32, for this happened to give average results in that way. Hence we restricted our table of departures of atmospheric transmission to spectrum place 32, and corresponding to the two arguments, "precipitable water" and "excess." Another table gave the old "function" value for Table Mountain corresponding to any atmospheric transmission observed as proper for place 32.

Before going on to use these results extensively, we selected over 70 satisfactory long-method days for which we tabulated the observed values of atmospheric transmission at places 36, 32, 28, and 20. The days selected covered a very wide range of atmospheric conditions as regards humidity and pyranometry. We next computed the atmospheric transparency at these spectrum places by our new process and took the differences observed minus computed transparency. These departures seldom exceeded 0.010, and their average was only about 0.002. However, there were disclosed certain systematic positive or negative departures corresponding to certain atmospheric conditions. Having evaluated these systematic errors, we revised our tables as required.

Only one further requirement now remained. We needed to use other air masses than $m=2.0$. To do this, we tabulated corresponding pyranometry at air masses 1.5, 2.0, and 2.5 for many excellent days and drew curves to represent these data. We already had curves of dependence of pyranometry on air mass, so that when observations were made at intermediate air masses they could be reduced to $m=1.5$, $m=2.0$, or $m=2.5$. From either of these standard air masses we could now determine by the new curves the reading which would be found at $m=2.0$ for a day of sky conditions similar to those actually prevailing on the day in question. For greater convenience, we combined the two sets of curves first mentioned into tabular form. An abstract of the combined table is given here in illustration.

TABLE 13.—*For reducing pyranometry to its equivalent at air mass 2.0*

Observed air mass						
1.2	1.5	1.7	2.0	2.2	2.5	2.7
140	144	147	150	152	154	155
160	168	173	180	184	191	195
174	184	190	200	206	215	221
186	199	207	220	228	239	245
205	223	234	250	260	274	283

Going on from the situation now reached, we can determine the "excess" from Figure 16, *E*; thence by a suitable table we can determine the corresponding old "function," and thence, as at Montezuma, proceed to determine the solar constant by the abridged short method. Such is now our procedure with Table Mountain observations. A numerical example follows:

TABLE 14.—*Example of short-method reduction at Table Mountain,*[1] *October 11, 1927. Adopted solar constant, 1.946 satisfactory*

Air mass, place 22	1. 50	1. 91	2. 00	2. 11	2. 51
Precipitable water (mm)	5. 7	6. 0	6. 1	6. 4	6. 2
Observed pyranometry	169	177	177	183	188
Equivalent pyranometry at air mass 2.0	181	179	177	181	177
Normal pyranometry	195	197	197	199	198
Excess pyranometry	−14	−18	−20	−18	−21
Equivalent function	22	22	22	23	22
A Area outside atmosphere	59, 720	60, 091	60, 549	61, 184	61, 219
B Area inside atmosphere (corrected for u. v. and i. r.)	52, 012	50, 693	50, 659	50, 607	49, 275
C Band areas (a)	5, 317	5, 758	5, 841	5, 984	6, 236
C Band areas (b)	5, 223	5, 752	5, 841	5, 955	6, 252
C Band areas (c)	5, 314	5, 765	5, 869	5, 927	6, 213
B–C Final inside area (a)	46, 695	44, 935	44, 818	44, 623	43, 039
B–C Final inside area (b)	46, 689	44, 941	44, 818	44, 652	43, 023
B–C Final inside area (c)	46, 698	44, 928	44, 790	44, 680	43, 062
Solar constant (a)	1. 943	1. 948	1. 940	1. 951	1. 947
Solar constant (b)	1. 943	1. 948	1. 940	1. 950	1. 948
Solar constant (c)	1. 943	1. 948	1. 941	1. 948	1. 947
Mean solar constant	1. 943	1. 948	1. 940	1. 950	1. 947
Sum of three corrections	+. 002	. 000	. 000	. 000	−. 002
Corrected solar constant	1. 945	1. 948	1. 940	1. 950	1. 945

[1] Certain details of the observations similar to those of Montezuma, of which a sample has already been given, are here omitted.

STATISTICAL CORRECTIONS

The descriptions above given may seem to be complex, but in practice, as the numerical illustrations show, once the tables are computed, solar-constant values may be quickly obtained at either station. Yet such values are not the final ones.

64772—32——9

However carefully the areas of the water-vapor bands of the infra-red energy spectrum are estimated, we can never hope to get thereby a perfectly accurate measure of the water-vapor absorption. Moreover, the plots correlating function values and atmospheric transmission coefficients are never fully satisfactory, especially because satisfactory determinations of atmospheric transmission coefficients can seldom be made on very hazy days. Hence, at best, the (F, a) curves are but fair approximations. Thus it comes about that the solar-constant values show some dependence both on the quantity of water vapor and on the value of the "function" prevailing. The solar-constant values obtained by the long method also depend on the status of atmospheric humidity. It is only by the statistical comparison of many values, obtained under all sorts of conditions, that these water-vapor and "function" corrections can be determined.

Nevertheless, we encounter the obstacle of real solar variability when we attempt to introduce statistical methods of making corrections for the atmospheric influences of humidity and haziness. For if we arrange the results secured in a short period of a few months, or even two or three years, in groups with steadily mounting values of the prevailing humidity, or haziness, it may readily occur that real changes of the intensity of the solar radiation which took place within the period of the discussion will confuse the order of values arranged with respect to humidity or haziness. This would not be troublesome if our discussion covered many years, for then the variations of the sun would be eliminated from the mean values.

We have devised two methods to eliminate solar variations in these statistical studies, and find both of them effective, and both leading to practically identical determinations of the atmospheric corrections desired.

First Method for Eliminating Solar Variations

Excepting for the nearly negligible effects of the variation of atmospheric ozone, a series of observations of the solar constant taken with identical water vapor, identical sky brightness, and all at one observatory, are assumed comparable without any corrections at all. Suppose we take all the observations of one observatory and divide them into such groups, each group including only a very narrow range of humidity and sky brightness. Each group of days indicates the solar variation in that group. But there is no way to pass from one group to another, so long as we have only one observatory.

But arrange the values similarly for the other observatory. Again we shall have the variation of the sun indicated strictly within each group, but have no means to pass from group to group. The days comparable at one observatory fall in various groups at the other. Thus, we find a great many independent determinations, sometimes as many as 20, of each crossing-over factor from one group to another. We take their mean indications, and so are able at length to put all of the observations at each observatory on a comparable footing. This method is applicable only to the short method, where very numerous days of observation are available.

Selected Pyrheliometry

The second method, and that which we have used most, is based on pyrheliometric observations made at times of equal air mass and of nearly equal status of precipitable water and apparent atmospheric transmission. It is, in short, an independent method of determining the principal solar variations. Before explaining its use in the present connection, we must first mention other aspects of this method of selected pyrheliometry.

This new method (to be further described in Chapter IV) was first described in the Monthly Weather Review, May, 1926, pages 191–194, where its application to Mount Wilson observations of July and August from 1910 to 1920 was explained. Later, in Smithsonian Miscellaneous Collections, volume 80, number 2, a similar treatment was presented of the Montezuma observations of all months from 1920 to 1926. In these two applications each month was treated by itself, in order to eliminate as far as possible all the sources of pyrheliometric error, if any, which might have an annual periodicity. For instance, it might be feared that the inclination of the pyrheliometer to the horizontal, or the exposure of it to sky brightness around the sun might involve periodic sources of error. Both comparisons cited above showed that, restricted to this, its original method of application, the new method of selected pyrheliometry gives almost identical percentages of variation of the sun to those resulting from the usual spectrobolometric method.

Correction of Solar-Constant Scale by Selected Pyrheliometry

The continuous character of the observations at Montezuma also gave opportunity for a valuable by-product of the method of selected pyrheliometry which is referred to in the second paper just cited. The percentages of departure of the mean of selected pyrheliometry of each month from the mean of all months of that name were computed for all months and compared with similar percentage departures of monthly means obtained by the short spectrobolometric method. It proved that in several instances the differences between these two sets of departures showed long-continued similarities. Thus, for instance, taking the differences (solar constant minus selected pyrheliometry) from August, 1920, to June, 1921, these differences were all positive; while from May, 1925, to April, 1926, they were all negative. Other such instances might be cited. On referring to the original sources it was found that in every pronounced case of a sudden change in this difference, some modification of the procedure of observing or of computing the solar constants had been made, whereby a systematic change of scale might possibly have been introduced. Hence, since the comparisons of pyrheliometers over this period did not indicate any changes in their scale,[12] we had no hesitation in applying to the solar-constant values certain systematic corrections thus determined, in order to reduce them to a constant scale throughout the period in question. Afterwards, the whole series of solar-constant values from 1924 to the present time was reduced to a consistent and definite system. But from 1920 to 1923 the values to be given in this Volume V of the Annals are merely corrected to constant scale in the manner just indicated.

Second Method for Eliminating Solar Variations

These valuable applications of selected pyrheliometry led us to consider whether this method may not be useful also in a preliminary way to eliminate the major solar variations to a sufficient degree to satisfy the demands of a study of statistical corrections for atmospheric conditions. As suggested above, it is indeed more proper to confine a comparison of selected pyrheliometry over a series of years to each month

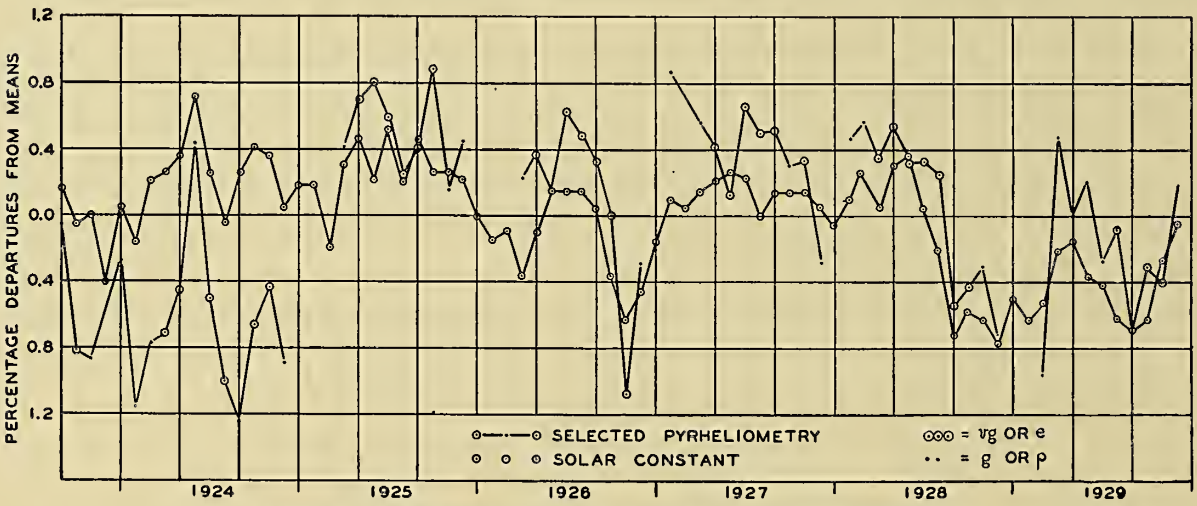

Figure 19.—Solar variation as indicated by selected pyrheliometry. Montezuma.

by itself, January by itself, July by itself, and so for other months. Yet it was believed by us to be highly probable that where, at moderate hour angles, the sun is always at high altitudes, the yearly range of the systematic errors of pyrheliometry is very small. So, then, if we take the mean value of selected pyrheliometry for the month of January with air mass 1.5 and precipitable water always between chosen narrow limits, we may assume that it is directly comparable to the corresponding quantities for other months. Proof of it will be found in Chapter IV.

Solar Variations by Selected Pyrheliometry and Bolometry Compared

Granting this assumption, we are now prepared to trace the broader features of the march of solar variation by selected pyrheliometry alone. Figure 19 gives such a treatment of Montezuma pyrheliometry for the years 1922–1929. Along with it, for comparison, is shown the march of the solar constant, according to our

[12] Except for the deposit of dust in December, 1922, for which correction had been made as already stated.

definitive reductions. The two curves show strong correlation, though the inferior accuracy of the method of selected pyrheliometry gives rise to minor discrepancies between them. Yet, it seems pretty clear that if, in our statistical study of the dependence of the preliminary solar-constant values on water vapor and atmospheric haziness, we first remove the major apparent solar fluctuations disclosed by selected pyrheliometry, the trustworthiness of the discussion will be increased. This, therefore, we have done.

Proceeding preferably by the method of selected pyrheliometry, so as to avoid any possibility of criticism that our results are dependent, one station on the other, we have first eliminated the major changes of solar radiation from the series of observations made at each station. This done, we have grouped the results at each station with reference to humidity, and with reference to haziness, and have obtained statistical corrections to the short-method solar-constant results which we have incorporated in tables. These corrections represent the statistical studies of Montezuma observations for the interval 1920 to 1926; of Table Mountain, 1926 to 1930; and of Mount Brukkaros, 1926 to 1930. In the tables of solar-constant values to be given below, these corrections are applied.

We have also been concerned to preserve from year to year the scale of solar-constant values which prevailed at Mount Wilson in the work published in Volumes II, III, and IV of the Annals. The introduction of the short methods, new observers, and observing stations at much higher altitudes have rendered this difficult. Yet by the help of the methods of selective pyrheliometry, and by graphical comparisons we believe that this desideratum has been attained closely. To promote comparability with Mount Wilson work a scale correction of −0.021 calorie has been applied on Montezuma short-method values since 1926. The following abbreviated table, in which this scale correction is included as well as the above-mentioned statistical correction, indicates by its small total range how very satisfactory the short-method values at Montezuma are in their preliminary form. The extreme range of the statistical corrections for that station for all air masses and from clearest to haziest days, is but 0.034 calorie. No additional correction at all is needed there for humidity. Table Mountain and Mount Brukkaros statistical corrections are more complex and a little wider in range. For lack of space we do not illustrate them here.

TABLE 15.—*Montezuma statistical corrections. Corrections for function and scale to be applied to final results of short-method tables to reduce them to the scale of 1913*

m=1.5		m=2.0		m=2.5		m=3.0	
F	Correction	F	Correction	F	Correction	F	Correction
240	−0. 020	300	−0. 012	300	−0. 011	400	−0. 009
400	−. 019	400	−. 018	400	−. 013	600	−. 013
600	−. 021	600	−. 020	600	−. 017	800	−. 016
800	−. 026	800	−. 022	800	−. 020	1, 000	−. 019
1, 000	−. 031	1, 000	−. 025	1, 000	−. 023	1, 200	−. 023
---------	-----------	1, 200	−. 030	1, 200	−. 027	1, 500	−. 028
---------	-----------	1, 500	−. 037	1, 500	−. 033	1, 800	−. 033
---------	-----------	---------	-----------	1, 800	−. 036	2, 100	−. 037
---------	-----------	---------	-----------	2, 100	−. 038	2, 400	−. 039
---------	-----------	---------	-----------	---------	-----------	2, 700	−. 042

Correction for scale (included in above figures) is −0.021.

Similarly we have found it necessary to apply statistical corrections to the results by the long method. But in this case, as the number of values was so small, we felt the need of correcting more accurately for solar variation. Accordingly, instead of applying the crude method of selective pyrheliometry, which is competent only to eliminate the larger swings of solar-constant fluctuation, we have assumed that the short-method results give the day-to-day solar changes correctly, and have eliminated them on that basis. This done, we have grouped the long-method values with reference to precipitable water prevailing, and have obtained small tabular corrections to the Montezuma, Table Mountain, and Mount Brukkaros long-method values. These are applied in the results to be given below.

ATMOSPHERIC OZONE AND THE SOLAR CONSTANT

The region of spectrum including wave lengths 4,800 to 6,300 Ångströms contains the so-called Chappuis bands of atmospheric absorption by ozone. It is an intense part of the solar spectrum as received at the earth's surface. This ozone band is so weak that it can not be clearly seen as a depression in a bolograph of the sun's energy spectrum. It nevertheless affects the total solar radiation as observed by the pyrheliometer, and produces, in temperate latitudes, where atmospheric ozone is at its maximum, a variable diminution of intensity which may be more than one per cent of the total solar energy reaching the earth's surface. The ozone bands in the ultra-violet occur where the solar spectrum is so much weaker that at least the variation of total solar radiation they introduce is negligible in our studies of solar variability.

A valuable paper[13] by Cabannes and Dufay employs the yellow-green atmospheric transmission coefficients determined by Smithsonian observers at Mount Wilson and Calama, Chile, 1908–1920, to estimate the amount and variability of ozone in the atmosphere above these stations. Mr. Fowle has also explained and illustrated a method for measuring the absorption of atmospheric ozone in the yellow-green region of the solar spectrum.[14] For this purpose he too employed the atmospheric transmission-coefficients observed in our application of Langley's method of solar-constant determination. Fowle showed that if a series of these coefficients, at wave-length intervals extending quite across the spectral region of the yellow-green ozone band called the "Chappuis band," is plotted against wave lengths or prismatic deviations, a depression of the curve occurs in the ozone band which is a measure of the quantity of ozone prevailing.

It is only since Mr. Fowle began his investigations of the Chappuis band several years ago, that we have thought of it as a source of error in solar-constant determinations. Indeed it is nearly negligible in the original Langley method. For the atmospheric transmission coefficients which are determined by that method are, of course, a little smaller in this spectral region whenever ozone is more plentiful. Their diminution nearly compensates for the depression of the pyrheliometer reading, by tending to increase the ratio of areas of bolographs (the computed outside, to the observed inside the atmosphere), by which the pyrheliometer reading is multiplied. There is no such approximate compensation in our "short methods" of solar-constant determination. Hence the absorption of ozone, if variable, tends to introduce an error in our series of determinations of solar variation.

Fortunately the variation of atmospheric ozone at the observing station on Mount Montezuma, Chile, is so small that the error is negligible.[15] Not so, however, at Table Mountain. We are therefore confronted with the necessity of correcting all "short-method" solar observations made at Table Mountain for the ozone effect.

Mr. Fowle's method, in which he employs atmospheric transmission coefficients in the yellow, is not generally applicable, for we observe on many days when transmission coefficients can not be determined independently[16] because only one or two bolographs can be taken between clouds. At Table Mountain we have employed Dobson's apparatus for measuring atmospheric ozone by observing the "Hartley ozone band" in the ultra-violet spectrum, but this apparatus was not installed there until about two years after the occupation of the station. However, a new method

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[13] Journal de Physique et le Radium, vol. 8, p. 253, 1927. In this connection the points for 1912 and 1914 of their Curve III, fig. 5, p. 363, should each be lowered 1 per cent. The first because the dust of Katmai directly increased the pyrheliometer readings. The second by reason of the results of a test of selected pyrheliometry. See Gerland's Beiträge zur Geophysik, vol. 16, Heft 4, pp. 359, 361, and 369, 1927.

[14] Atmospheric ozone. Smithsonian Miscellaneous Collections, vol. 81, no. 11, 1929.

[15] See in this connection Dobson, Proceedings of the Royal Society, Series A, vol. 122, p. 467, 1929.

[16] Short-method determinations from mean curves of function and transmission do not give the relative ozone effects of individual days.

has recently been devised by Doctor Abbot which is available at all times when bolographic observations have been taken. It seems to be of quite sufficient accuracy to serve to determine the small ozone corrections for the solar constant, and even to give a fair idea of the variations of the absolute quantity of ozone prevailing.

We are accustomed to measure the ordinates of bolographs very accurately at certain nearly equally spaced places on the photographic plates. These places correspond, in fact, to a series of prismatic deviations, which we are accustomed to call 36, 34, 32, 30, 28, 26, 24, 22, 20, 19, 18, 17, 16, naming them from their approximate distances in centimeters on the photographic plate from the band ω_1 in the infra-red. The corresponding wave lengths as actually observed at Table Mountain are, respectively, in microns: 0.409, 0.433, 0.427, 0.471, 0.496, 0.529, 0.568, 0.616, 0.694, 0.732, 0.774, 0.819, and 0.872. We use as standards of ordinates the mean values at these points on a series of days in the autumn of 1928—August 1, October 3, November 4, December 18, and December 19—when nearly minimum ozone, excellent sky, and good instrumental conditions prevailed. It is necessary, however, to restrict ourselves to comparable air masses, and for this purpose we chose first to deal with air masses 2.0 and 2.5, which have been employed in our observing very generally.

If, then, we divide the mean values of the ordinate readings at the places mentioned above, as observed on the standard days of 1928, into the comparable readings on other dates, we have for each new day a series of ratios covering the spectral region selected. If the new day has equally transparent sky and an equal quantity of atmospheric ozone, the series of ratios will be found nearly constant throughout the interval. If the sky is of different transparency, but the ozone quantity equal to the average prevailing during the standard days, then the ratios will gradually decrease or gradually increase as we pass from place 36 to place 16, according as the atmosphere of the new day is more or less transparent. This is because the changes of transparency affect the shorter wave-length rays more than the longer ones. In either case thus far considered, a plot of ratios taken as ordinates, against places in the spectrum taken as abscissae, will be nearly a straight line, horizontal if the transparency is unchanged, and inclined if the transparency is altered.

But suppose there is a greater quantity of ozone prevailing on the new day. Then the plot of ratios will show decreased ordinates in the region 28 to 20, with maximum effects at places 24 and 22, corresponding to wave lengths 0.568 and 0.616 microns. Figure 20 shows a series of days thus treated, employing both air masses 2.0 and 2.5, and dealing with very different quantities of ozone. It will be seen that the effects are considerable as compared to the errors of observing them, and that the two different air masses give closely agreeing results.

Using the average atmospheric transmission coefficients obtained by Langley's method for the standard days, we have computed what the ordinates would have

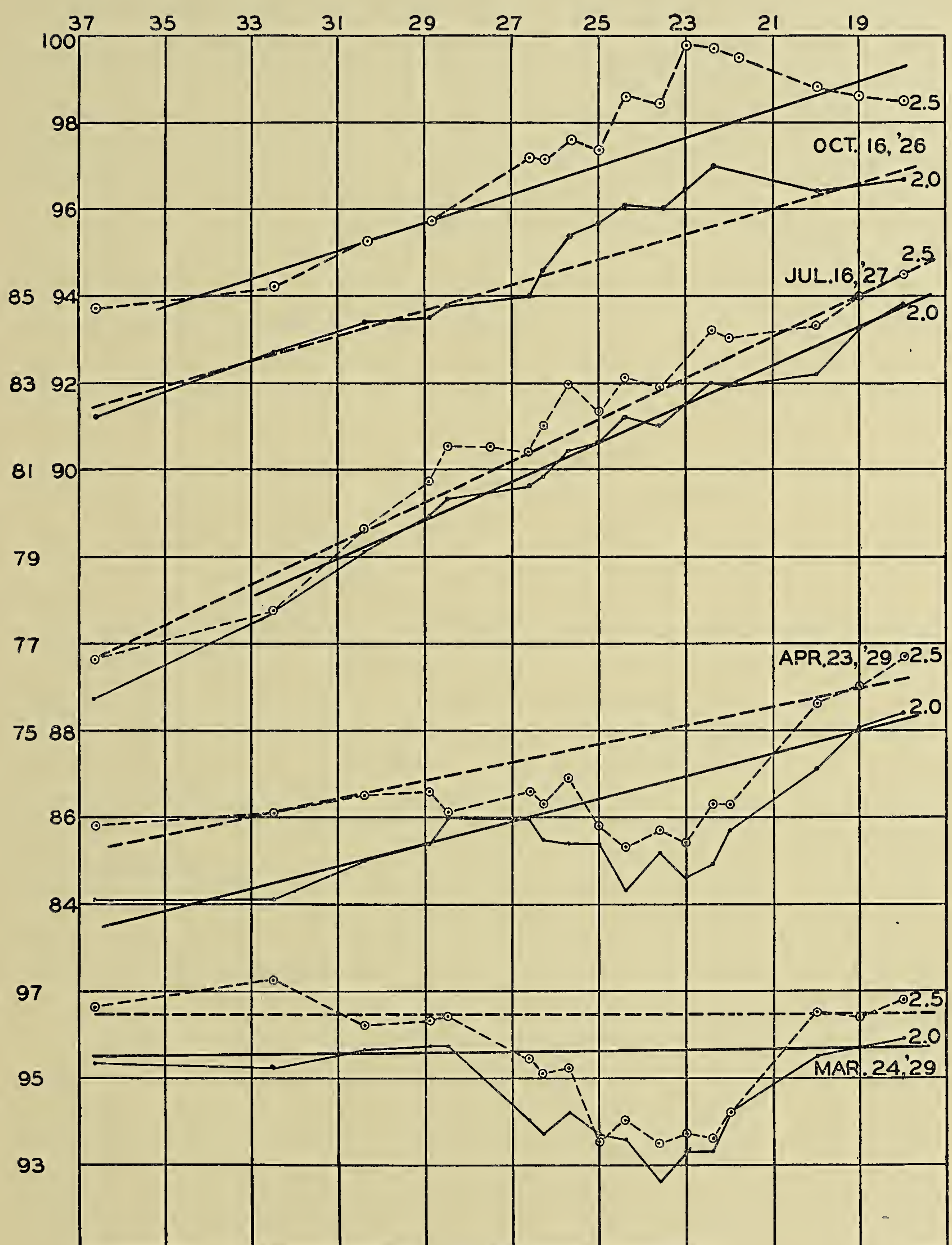

FIGURE 20.—Ozone determination

averaged at the selected places on those days if other air masses than 2.5 and 2.0 had been observed. By plotting air masses against such computed ordinates, we were able to extend the application of the new ozone method to any air mass at which observations were made on any day.

In order to correct solar-constant results for ozone absorption, it is unnecessary to know the actual quantities of ozone which correspond to such plots as those given in Figure 20. For instance, the following values were read off from smoothed ratio plots of April 23, 1929, a day of high ozone value:

Place	28	26	24	22	20	Air mass
a. Observed	.845	.862	.846	.850	.871	2.0
b. Straight line	.856	.862	.867	.873	.879	
c. $\frac{b}{a}$	1.0130	1.000	1.0248	1.0271	1.09	
a. Observed	.858	.862	.855	.861	.886	2.5
b. Straight line	.870	.875	.880	.884	.888	
c. $\frac{b}{a}$	1.0140	1.0151	1.0292	1.0267	1.0023	

In the results, *c*, in the third lines of the two groups in the above table, we have the multipliers which should be applied to the ordinates of the bolographs taken at air masses 2.0 and 2.5 on April 23, 1929, to reduce them to what they would have been if the ozone of that date had been equal to the average value of the standard days. Performing these corrections and summing up the areas included under the observed and the ozone-corrected bolographic energy curves, we find that the ozone correction on April 23, 1929, increases the area of the energy curve by 0.45 per cent, according to results at air mass 2.0; and by 0.44 per cent according to results at air mass 2.5. The mean value, 0.45 per cent, is a correction to be added to the solar-constant value obtained by the short method on April 23, 1929, to reduce it to the status of ozone prevailing in the average of standard days. Though corrections larger than this will rarely occur, they will sometimes be nearly as large as this negatively, so that these corrections range through nearly 1 per cent at Table Mountain, and are by no means negligible.

Dr. Oliver R. Wulf, of the Fixed Nitrogen Research Laboratory, United States Department of Agriculture, has made photographs of the absorption spectrum of ozone in this yellow-green region. Though the resolving power of his apparatus was fairly high, they show the ozone influence as broad, ill-defined bands. The distribution of ozone absorption indicated by these photographs suggested the thought that before finally reducing the new ozone method to a system of corrections to solar-constant work it would be preferable to measure a number of bolographs corresponding to a wide range of ozone at numerous places between wave lengths

0.48 and 0.63 microns. In this way a more thorough basis for estimating the corrections proper to apply to the solar-constant values would be laid. Accordingly Mr. Aldrich measured plates of October 12 and 16, 1926, December 8, 1928, and March 24, April 14, and April 23, 1929. These curves he measured at wave lengths 0.490, 0.495, 0.524, 0.530, 0.541, 0.555, 0.568, 0.587, 0.601, 0.616, and 0.628 microns within the ozone region. Several of the ratio plots representing his results have been reproduced in Figure 20.

The observations were quite as consistent as could be expected, and indeed remarkably so when it is recollected that every observed ordinate of one of the original bolographs depends on measures of distances between photographic curved lines and base lines each of at least a millimeter in thickness. The base lines are ruled with India ink according to the best judgment of the observer so as to pass through photographic traces of the zeros of intensity. The traces of the zeros are separated longitudinally by some 20 cm. The ordinates of bolographs as thus determined average only about 50 mm each, so that 1 per cent corresponds on the average to 0.5 mm. Accidental disturbances of the bolographic apparatus, as well as temporary changes of atmospheric transparency, produce their full effects as errors. Under these circumstances, the satisfactory consistency of the following table is indeed surprising.

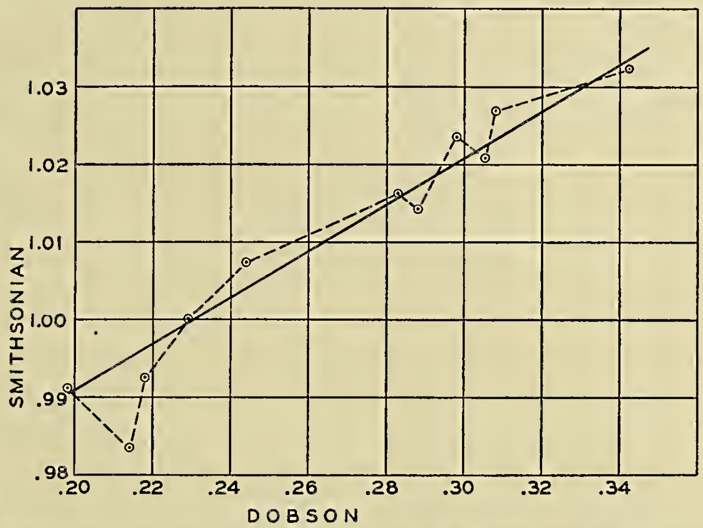

FIGURE 21.—Comparison of ozone determinations by Smithsonian and Dobson methods

TABLE 16.—*Ratios of intensity values indicating absorption by ozone. Ratios (c), as directly read from ozone plots* [1]

Date	Air mass	Place									
		21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	22.4	24.4
Apr. 23, 1929	2.5	137	266	316	281	221	104	196	209	220	293
	2.0	116	175	272	236	123	082	000	−047	259	273
Mar. 24, 1929	2.5	126	234	288	288	312	137	084	031	299	255
	2.0	095	149	246	268	203	180	116	−083	246	214
Apr. 14, 1929	2.5	057	092	093	093	082	083	060	024	092	082
	2.0	067	103	150	128	105	094	217	108	114	081
Oct. 12, 1926	2.5	−088	−125	−135	−078	−049	040	−049	−030	−044	−073
	2.0	−088	−133	−108	−109	−070	000	061	020	−047	−128
Oct. 16, 1926	2.5	−081	−081	−211	−122	−031	−062	−052	−021	−181	−142
	2.0	−073	−124	−114	−104	−094	−053	032	010	−144	−115
Dec. 8, 1928	2.5	−059	−108	−108	−146	−079	−040	−010	−020	−127	−175

[1] The figures given are departures from unity, expressed in ten-thousandths. Thus: Apr. 23, m=2.5, 1.0137, etc.; Oct. 12, m=2.5, 0.9912, etc.

Corrections to the solar-constant values were worked out independently for each of the dates and air masses just given. The matter may be summarized as follows:

TABLE 17.—*Ozone corrections to solar constant. Table Mountain*

Date	Air mass	Ratios (c) at—		Percentage correction to solar constant
		22.4	24.4	
Apr. 23, 1929	2. 5	1. 0220	1. 0293	0. 46
	2. 0	1. 0259	1. 0273	0. 38
Mar. 24, 1929	2. 5	1. 0299	1. 0255	0. 44
	2. 0	1. 0246	1. 0214	0. 44
Apr. 14, 1929	2. 5	1. 0092	1. 0082	0. 22
	2. 0	1. 0114	1. 0081	0. 18
Oct. 12, 1926	2. 5	0. 9956	0. 9927	−0. 20
	2. 0	0. 9953	0. 9872	−0. 21
Oct. 16, 1926	2. 5	0. 9819	0. 9858	−0. 22
	2. 0	0. 9856	0. 9885	−0. 20
Dec. 8, 1928	2. 5	0. 9873	0. 9825	−0. 18
Standard days	--------	1. 0000	1. 0000	0. 00

These values were plotted, and the best curves were drawn to represent the data. Thus the following tabular corrections, to be applied to solar-constant values determined at Table Mountain by the short method, were obtained:

TABLE 18.—*Percentage ozone corrections to short-method solar-constant values, Table Mountain*

Place 22 (really 22.4):						
Ratio (*c*)	1. 03	1. 02	1. 01	1. 00	0. 99	0. 98
Correction	0. 50	0. 35	0. 19	0. 00	−0. 25	−0. 49
Place 24 (really 24.4):						
Ratio (*c*)	1. 03	1. 02	1. 01	1. 00	0. 99	0. 98
Correction	0. 49	0. 33	0. 17	0. 00	−0. 18	−0. 37

The solar-constant values from Table Mountain have been corrected thus.

In order to determine the actual atmospheric content of ozone at Table Mountain we may proceed in several different ways.

1. Numbers expressing the excess of ozone over the standard quantity can be derived by taking mean values of the ratios, $c=\frac{b}{a}$, such as have just been given.

As the ozone effect is largest and nearly the same at places 22 and 24, we have preferred to use these ratios only, but have employed two air masses when available, though the different air masses usually accord fairly closely, as indicated by the preceding results of April 23, 1929. The following table gives such results corresponding to the standard days and to 10 other days compared to them, along with the values of ozone at Table Mountain on these dates as determined by Doctor Dobson, and expressed in centimeters of the gas if existing at standard temperature and pressure.

TABLE 19.—*Smithsonian and Dobson ozone measures compared*

Date	1929						1928				
	Mar. 24	Apr. 23	Mar. 23	Mar. 25	Mar. 26	Mar. 16	Dec. 17	Standard	Nov. 16	Dec. 8	Dec. 9
Mean $c=\frac{b}{a}$	1.0323	1.0269	1.0234	1.0209	1.0161	1.0142	1.0074	1.0000	0.9925	0.9912	0.9835
Dobson ozone	0.342	0.308	0.298	0.305	0.283	0.288	0.244	0.229	0.218	0.198	0.214

These results are plotted in Figure 21. From the straight line representing them we find the equation:

$$\text{Dobson ozone} = \frac{\text{mean } c - 0.9310}{0.3}$$

2. As an independent method of reducing bolographic observations to yield quantities of atmospheric ozone, Mr. John A. Roebling made it possible, through the cooperation of Dr. F. G. Cottrell, lately director of the Fixed Nitrogen Research Laboratory, to have Doctor Wulf of that laboratory make standardizing observations at Table Mountain. He inserted measured quantities of ozone in the path of the solar beam. These observations were made on fine autumn days of 1930, when the quantity of atmospheric ozone was nearly at minimum. Doctor Wulf arranged an absorption tube with optical glass ends in front of the spectrobolometer slit. Through this tube he drew ozone-bearing air, and measured the concentration of ozone chemically at frequent intervals. His results will be published in the Smithsonian Miscellaneous Collections.

Chapter IV

PYRHELIOMETRY AND PYRANOMETRY

We quote as follows from Annals, Volume IV, page 89:

The basis of our research lies in the exactness and stability of its pyrheliometry. We are watching for changes in the radiation of the sun from day to day and from year to year. In doing so we determine the values of the intensity of solar radiation outside of the atmosphere in calories per square centimeter per minute. The accuracy of the comparisons depends, however, primarily on the exact comparability over long intervals of our observations at the earth's surface. As the bolometer (which we are obliged to use in order to determine the transparency of the earth's atmosphere) is not a standard instrument for measuring radiation, and gives merely relative values, it is necessary to standardize it against some other instrument. For this purpose we have chosen the pyrheliometer.

As already stated in Chapter II of this volume:

It will be recalled that in substance our determination of the solar constant consists in multiplying the reading of the pyrheliometer by the computed ratio of the area which a bolograph taken outside the atmosphere would embrace compared to that of one taken at the earth's surface.

A principal part of the fractional error of the solar constant is therefore directly proportional to the fractional error of the pyrheliometer reading. It is a prime requisite of the comparability of solar-constant values over a term of years that the pyrheliometers used in the determination should have maintained a constant scale during the entire interval. As a safeguard against changes of scale we maintain three silver-disk pyrheliometers at each field station, one of which, rarely used, is kept for standardizing purposes.

MONTEZUMA PYRHELIOMETRY

At Montezuma, pyrheliometers S. I. 29 and S. I. 30 are read together nearly simultaneously ten or more times each on every day when solar-constant values are obtained. Pyrheliometer S. I. 17 is used as a comparison standardizing instrument, and is read for this purpose only, and perhaps on no more than a dozen days in a year. To illustrate the close uniformity of scale that has obtained in the daily pyrheliometer readings at the Chilean station, we give the following table (Table 20). In making the comparisons here reported, pyrheliometers S. I. 17 and S. I. 29 are first read about five times each by the two observers, A and B respectively, and then are reread the same number of times in the order B and A. Thus personal equation is eliminated in the final ratio resulting.

Table 20.—*Comparisons of pyrheliometers at Montezuma, S. I. 17, S. I. 17 bis, and S. I. 29*

Date	Mean ratio Nos. 17/29	Per cent deviation from mean	Date	Mean ratio Nos. 17/29	Per cent deviation from mean	Date	Mean ratio Nos. 17 bis /29	Per cent deviation from mean
Sept. 19, 1919	1.0134	−0.25	May 6, 1926	1.0155	−0.04	Feb. 13, 1929	1.0060	−0.07
Aug. 23, 1920	1.0112	−0.47	Nov. 2, 1926	1.0170	+0.11	Mar. 15, 1929	1.0036	−0.31
Nov. 21, 1921	1.0166	+0.07	Jan 6, 1927	1.0165	+0.06	Apr. 23, 1929	1.0105	+0.38
Apr. 29, 1924	1.0160	+0.01	Apr. 12, 1927	1.0183	+0.24	May 24, 1929	1.0060	−0.07
May 2, 1924	1.0134	−0.25	May 27, 1927	1.0138	−0.21	July 12, 1929	1.0051	−0.16
June 16, 1924	1.0155	−0.04	June 24, 1927	1.0161	+0.02	Aug. 30, 1929	1.0071	+0.04
Aug. 24, 1924	1.0136	−0.23	July 19, 1927	1.0166	+0.07	Nov. 9, 1929	1.0046	−0.21
Mar. 12, 1925	1.0180	+0.21	Sept. 10, 1927	1.0140	−0.19	Dec. 4–21, 1929	1.0052	−0.15
Mar. 24, 1925	1.0163	+0.04	Mar. 22, 1927	1.0196	+0.37	Apr. 29, 1930	1.0096	+0.29
Mar. 25, 1925	1.0150	−0.09	Apr. 24, 1927	1.0184	+0.25	May 23, 1930	1.0096	+0.29
			July 5, 1927	1.0195	+0.36	June 25, 1930	1.0060	−0.07
			Old Mean	1.0159		New Mean	1.0067	
						Mean of 32 deviations		+0.18

In January, 1929, Mr. Aldrich carried the standardizing pyrheliometer S. I. 17 from Montezuma to La Quiaca, Argentina, to make a standardization there. A slight injury occurred so that it became necessary to reinsert and reblacken its silver disk. This caused a change of the ratio 17/29 from 1.0159 to 1.0067 as indicated in the table.

Otherwise than as attending this repair early in 1929, it is apparent that the pyrheliometers have retained their relative scales sensibly unchanged over a period of more than 11 years. The average deviation of the 32 individual comparisons from the mean is but 0.18 per cent. No tendency to change of scale in pyrheliometer S. I. 29 in either direction is clearly distinguishable. Hence, so far as dependent on the constancy of the pyrheliometers themselves, we may conclude that the average yearly values of the solar constant observed in Chile are accurately comparable.

When, however, we consider the comparability of monthly and daily values, additional information is required. It might be that seasonal and daily differences in the brightness of the sky close to the sun, or differences in the inclination of the pyrheliometer at different times of the year, would introduce systematic errors. The first of these possibilities has been discussed in Chapter II, where it was shown that no sensible error depending on sky brightness affects the results. The second possibility may be treated in the following manner.

SELECTED PYRHELIOMETRY

Practicing the method of selected pyrheliometry already referred to, we chose from every month of observation at Montezuma, from 1920 to 1929 inclusive, all of the days when the precipitable water lay between 1 and 5.5 mm. We separated these values into three groups with the ranges of precipitable water 1–2, 2–3, 3–5.5 mm, respectively. Also, we divided the data into two general groups, 1920–1924 and 1925–1929, respectively. Having computed the percentage departures from the mean in each of the three precipitable-water groups, we took the mean of these three mean departures to cover and represent the whole range of precipitable water, 1–5.5 mm.

In Table 21, and in the plots of Figure 22, these mean departures are given in terms of 100 per cent.

TABLE 21.—*Percentage of departures in yearly march of selected pyrheliometry at Montezuma*

MEAN OF YEARS 1920 TO 1924

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
% Δ	−0.05	−0.25	+0.02	+0.10	−0.05	+0.80	+0.10	−0.55	+0.05	−0.20	−0.22	−0.18
Number cases	13	4	20	24	23	25	27	32	49	59	44	20
MEAN OF YEARS 1925 TO 1929												
% Δ	+0.02	+0.12	+0.25	+0.18	+0.42	+0.40	+0.18	+0.27	−0.10	−0.10	−0.65	−0.67
Number cases	4	8	8	74	85	67	85	65	81	86	59	38

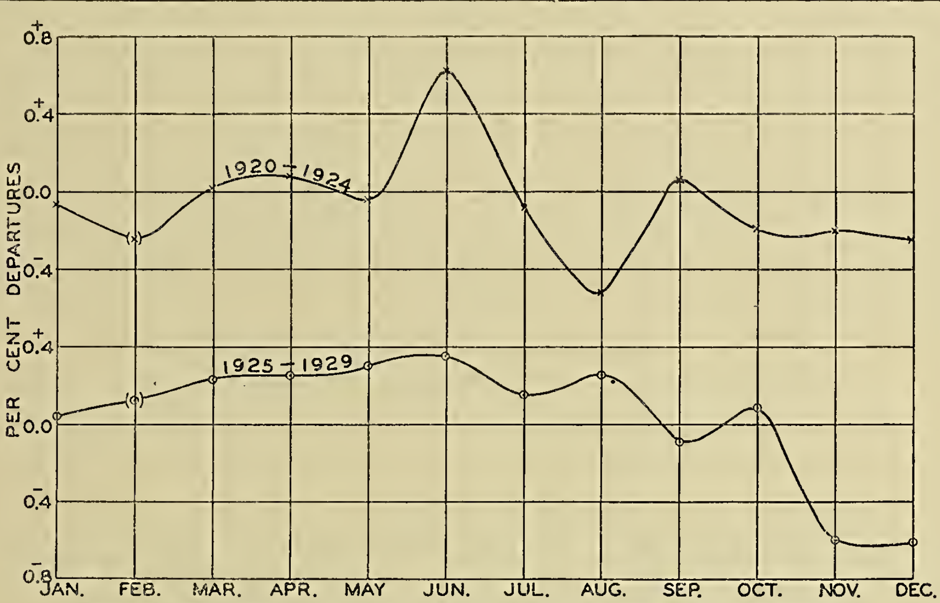

FIGURE 22.—Percentage departures in yearly march of selected pyrheliometry at Montezuma

It is apparent that the range of selected pyrheliometry through the year in each of the 5-year intervals barely exceeds 1 per cent.

Excluding the months of June and August in the first period, and November and December in the second, the ranges are reduced to one-quarter and one-half per cent, respectively. The fluctuations show no seasonal similarity for the two periods. Therefore, we ascribe the small deviations from constancy to the combined effects of real variability of the sun and of slight unavoidable noncomparability of the conditions as regards precipitable water. We think it fair to conclude that no appreciable yearly march of the pyrheliometer occurs at Montezuma. Hence, both long-term and short-term periodicities being excluded, we believe the solar-constant values observed at Montezuma since 1920 are closely comparable so far as they depend on atmospheric influences affecting pyrheliometry.

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ACCURACY

We desire at this point to discuss a criticism of our pyrheliometry which was made several years ago by Doctor Linke.[1] We translate his remark as follows:

> I hold it as quite impossible that the silver-disk pyrheliometer can be read at a single measurement to an accuracy of 0.1 per cent or even 0.2 per cent. The thermometer is exposed to solar radiation for 100 seconds and then read. During this interval the rise of temperature is about 3°, which may be observed only to an accuracy of 0.01°. Since besides this the time interval enters in, which can not be estimated closer than about 2 seconds[2] [sic], it follows that the accuracy of single observations can not exceed about 0.5 per cent. At a single set of readings, two to four exposures are made by which the accuracy of the mean of a set may be increased, and reach 0.3 to 0.4 per cent.

To illustrate the observed facts relating to readings of the silver-disk pryheliometer, we give the following complete summary of a series of 10 comparisons between pyrheliometers S. I. 17 and S. I. 29 made at Montezuma on April 24, 1928. These are usual, and not specially selected results, nor were these observers exceptionally expert ones: Observers, H. H. Zodtner and M. K. Baughman. First set: H. H. Z. reads No. 17; M. K. B. reads No. 29. Second set: H. H. Z. reads No. 29; M. K. B. reads No. 17. In the following table "Corrected observation" means the observed rise of temperature during a single 100-seconds' exposure to solar radiation, plus the mean fall of temperature determined during two 100-second cooling periods before and after the exposure. All readings are corrected for calibration of thermometer stem, and to standard temperature of instrument.

TABLE 22.—*A comparison of pyrheliometers at Montezuma*

Mean time of exposure	Observers direct				Mean time of exposure	Observers reversed			
	No. 29 Corrected observation	No. 17 Corrected observation	$\frac{\text{No. 17}}{\text{No. 29}}$ Ratio	% Δ from mean ratio		No. 29 Corrected observation	No. 17 Corrected observation	$\frac{\text{No. 17}}{\text{No. 29}}$ Ratio	% Δ from mean ratio
h. m.	°	°			*h. m.*	°	°		
10 7	4.245	4.338	1.0219	0.69	10 55	4.262	4.389	1.0298	0.79
10 11	4.302	4.361	1.0137	0.13	10 59	4.279	4.341	1.0145	0.26
10 15	4.328	4.394	1.0152	0.02	11 03	4.283	4.384	1.0236	0.17
10 19	4.333	4.388	1.0127	0.23	11 07	4.293	4.412	1.0277	0.58
10 23	4.345	4.394	1.0113	0.37	11 11	4.318	4.379	1.0141	0.78
	Direct mean, 1.0150					Reversed mean, 1.0219			

Mean of 10 deviations, 0.40 per cent.

Probable error of one reading, $\frac{0.84 \times 0.40}{\sqrt{2}} = 0.24$ per cent.

These results may reassure Doctor Linke as to the reality of the accuracy as regards accidental errors which we claim for the observations of the silver-disk pyrheliometer.

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[1] Meteorologische Zeitschrift, Mar., 1924, p. 74.

[2] We presume there is here an error of the printer, and that Doctor Linke intended one-half second in place of 2 seconds.

PERSONAL EQUATION

On November 5 and December 21, 1929, Mr. H. H. Zodtner, then field director at Montezuma, wrote:

In reading the pyrheliometers, there is a marked personal equation between Mr. Butler and myself.

The mean of simultaneous comparisons in which the instruments were reversed every five readings indicates that my readings are higher than his. Therefore when I read the pyrheliometer I shall reduce the value.

Mr. Zodtner seldom read the pyrheliometer at Montezuma. Nearly all of the readings of it were made either by Baughman or by Butler during Zodtner's occupation at Montezuma. Hence the matter was of minor consequence so far as he was concerned, but we were led to investigate the whole subject as a source of error.

Let observers A and B read simultaneously pyrheliometers M and N, in the order AM, BN, and after a certain number of readings they reverse instruments, reading in the order AN and BM. Let $1+x$ be the true ratio of $\frac{M}{N}$, and let $1+y$ be the ratio of reading habits, $\frac{A}{B}$. Let r_1 and r_2 be the mean ratios observed of $\frac{M}{N}$ under the first and second arrangements, respectively.

Then

$$\frac{r_1}{r_2}=\left(\frac{1+x}{1+x}\right)\left(\frac{1+y}{1-y}\right)=(1+2y) \text{ approximately}$$

$$y=\tfrac{1}{2}\left(\frac{r_1}{r_2}-1\right)$$

Proceeding in this way we have determined the relative personal equations between all the pairs of observers who have been concerned in the pyrheliometer readings. The investigation covers thousands of results of 13 years. A. F. Moore observed in every year. Either by direct comparisons or indirectly through a third party, we reduced all of these results to A. F. Moore's habit of reading as a basis. We then computed the average deviations relative to Moore. We determined the average for all observers and derived the following table of personal equations relative to the general mean.

Observer	Per cent personal equation	Observer	Per cent personal equation
A. F. Moore	+0. 12	H. H. Zodtner	+0. 13
L. H. Abbot	−0. 03	M. K. Baughman	−0. 21
P. E. Greeley	+0. 12	C. P. Butler	−0. 24
F. A. Greeley	+0. 08	L. O. Sordahl	+0. 07
L. B. Aldrich	−0. 29	W. H. Hoover	−0. 02
E. E. Warner	−0. 02	E. E. Smith	+0. 05
H. B. Freeman	−0. 05	W. W. Weniger	+0. 07

After reflection we decided not to apply corrections to eliminate these personal equations. They are all small. Excepting in the cases of Aldrich, Baughman, and Butler, they are hardly appreciable and perhaps not beyond the variability of the personal equations themselves. As far as concerns short-period solar variations, the personal equations, even if real, will comparatively seldom change the result, because the general practice has been for one observer to read for many days consecutively. As far as they affect the monthly mean values, they will seldom be of importance because the observers will generally have been exchanged during so long an interval as a month, which tends to reduce the error. However, having recognized this small source of error, we contemplate substituting soon other observing instruments whereby personal equation may be eliminated altogether.

MOUNT HARQUA HALA AND TABLE MOUNTAIN PYRHELIOMETRY

The satisfactory constancy of scale of the Chilean pyrheliometry throughout the whole term of years during which daily solar-constant measurements have been in progress is an invaluable asset. It gives us a standard scale to which results of other stations may be reduced. We are investigating only the sun's variability. The best value of the solar constant is not in question. Our mean value, 1.94 calories per square centimeter per minute, is believed by us and by our critics generally to be very near the true one. We are content to let it remain so until some special investigation of the future may improve it. Hence the independent testimony of two or more stations as to the scale of the daily values is not important. Our primary concern is merely to retain the same scale at all stations at all times. Hence, with the Chilean scale established as a constant one, and, as shown in Volume IV of these Annals, harmonious with the scale of the Mount Wilson observations of 1905 to 1920, our concern is merely to reduce the scales of the other observations to agree with the Chilean one.

Thus the pyrheliometers at Mount Harqua Hala, Table Mountain, and Mount Brukkaros become merely secondary standards. They serve their purpose if they keep a sufficiently constant scale at these other observatories over considerable time intervals, so that only infrequent adjustments to the Montezuma scale become necessary. We shall keep this point in mind in what follows.

At Mount Harqua Hala, 1924–25, and Table Mountain, 1925 to the present time, silver-disk pyrheliometers A. P. O. 10 and S. I. 32 have been read together nearly simultaneously in the daily observing. At Mount Harqua Hala, 1920–1924, we used A. P. O. 9 and S. I. 32 for this purpose, but substituted A. P. O. 10 for A. P. O. 9 in 1924 because of certain small irregularities observed in the readings of A. P. O. 9. Standardizing comparisons have been made frequently. Pyrheliometer I. 5 was used on several occasions, but from October, 1924 to September, 1929, S. I. 42 has been maintained as an extra pyrheliometer at the station for that purpose. Since September, 1929, pyrheliometer A. P. O. 12, which has a 12½-inch vestibule, has been substituted for S. I. 42.

Referring to Chapter II, the reader will recall that during the year 1923 and early in 1924 the Montezuma pyrheliometer scale was temporarily altered by dust. This being discovered, attention was more sharply directed to this as a source of error at other stations, and it is now the practice to lightly brush the blackened ray-receiving surfaces from time to time. On several occasions some slight dust effects were noted at Table Mountain, as will appear in notes attached to the following table. Corrections have been applied to solar-constant values to eliminate observed dust errors.

TABLE 23.—*Comparisons of pyrheliometers, Harqua Hala and Table Mountain*

Date	Number of comparisons	Ratio A. P. O. 9 / S. I. 32
1920 Aug. 30	11	[1] 1.0236
Nov. 19–Dec. 7	15	[2] 1.0276
1921 Feb. 24–Mar. 8	12	1.0280
1922 June 29	11	1.0289
1924 Jan. 8	14	1.0280
		Ratio S. I. 5 / S. I. 32
1922 June 19	10	1.0129
June 29	14	1.0195
July 10	12	1.0195
1924 July 6	8	1.0082
Oct. 8	10	1.0190
		Ratio S. I. 42 / S. I. 32
1924 July 6	6	1.0061
Dec. 3	10	1.0177
1926 Jan. 5	10	1.0305
1927 Apr. 18	10	1.0352
May 26	5	1.0312
May 31	10	[3] 1.0258
July 11	10	1.0141
Aug. 2	10	1.0069
Nov. 10	10	1.0110
1928 June 14	12	1.0142
June 27	10	1.0106
Oct. 9	10	1.0113
		Ratio S. I. 42 / A. P. O. 10
1926 Jan. 5	10	1.0121
1927 Apr. 18	9	[4] 1.0119

Date	Number of comparisons	Ratio S. I. 42 / A. P. O. 10
1927 May 31	10	1.0073
July 11	8	1.0047
Aug. 2	10	1.0077
Nov. 10	10	1.0100
1928 June 15	13	1.0056
July 2	10	1.0100
Oct. 9	10	1.0113
		Ratio A. P. O. 10 / A. P. O. 12
1929 Sept. 25	10	[5] 1.0279
Sept. 28	10	1.0295
Oct. 17	14	1.0295
1930 Feb. 12	10	1.0292
Feb. 13	11	1.0302
July 3	11	1.0373
July 19	12	1.0318
July 21	11	1.0331
July 22	12	1.0300
July 23	10	1.0329
		Ratio S. I. 32 / A. P. O. 12
1929 Sept. 26	10	1.0315
Sept. 29	10	1.0299
Oct. 17	12	1.0270
1930 Feb. 12	12	1.0259
Feb. 13	13	1.0279
July 3	11	1.0289
July 19	11	1.0258
July 22	14	1.0298
July 23	12	1.0293

[1] This comparison is indirect through Standard Water-Flow Pyrheliometer No. III.

[2] In the comparisons reported from Nov. 19, 1920, to Mar. 8, 1921, pyrheliometer S. I. 32 was read 2 minutes after A. P. O. 9. The subsequent comparisons reported in this table were through simultaneous observations.

[3] Dust was removed from the disk of S. I. 32 after this reading, and the instrument was well dusted in all subsequent readings.

[4] Dust was removed from the disk of A. P. O. 10 after this reading, and the instrument was well dusted in all subsequent readings.

[5] Pyrheliometer A. P. O. 12 was first sent out as a standard in 1928, but arriving in a defective condition was returned to Washington, repaired, and sent back in September, 1929.

COMPARISONS OF PYRHELIOMETERS AT WASHINGTON

Readers are referred to Tables 10 and 11 of Volume IV of the Annals for data regarding standardizations and intercomparisons of numerous pyrheliometers during the period 1913 to 1920.[a] The following Table 24 is in continuation of those results. The average probable error of the ratios A/B in the table is 0.0018.

TABLE 24.—*Comparisons of pyrheliometers. General*

Date	Number of comparisons	Pyrheliometers used		Ratio A/B
		A	B	
Feb. 13, 1917	8	S. I. 1	A. P. O. 8_{bis}	1.0360
Nov. 5, 1917	5	do	do	1.0330
May 3, 1920	8	do	do	1.0352
Apr. 23, 1927	8	do	S. I. 5	1.0114
June 17, 1927	10	do	do	1.0156
Feb. 27, 1928	8	do	do	1.0044
Do	8	do	A. P. O. $8_{bis\ bis}$	1.0468
Mar. 11, 1929	8	do	S. I. 5	[1] 0.9727
Apr. 2, 1929	8	S. I. 1_{bis}	do	[2] 0.9877
Do	8	do	A. P. O. $8_{bis\ bis}$	1.0168
Apr. 19, 1929	8	do	do	1.0128
Do	8	do	S. I. 5	0.9840
June 3, 1930	8	do	A. P. O. $8_{bis\ bis}$	1.0195
Oct. 14, 1921	12	S. I. 5	A. P. O. 8_{bis}	1.0339
Mar. 6, 1922	20	do	do	1.0291
Oct. 10, 1927	8	do	do	1.0457
Oct. 22, 1927	20	do	do	1.0305
Nov. 1, 1927	20	do	do	1.0395
Dec. 1, 1927	8	do	A. P. O. $8_{bis\ bis}$	[3] 1.0328
Dec. 27, 1927	8	do	do	1.0311
Feb. 27, 1928	8	do	do	1.0422
July 27, 1929	8	S. I. 16_{bis}	do	[4] 1.0359
May 3, 1920	5	S. I. 20	A. P. O. 8_{bis}	1.0368
Sept. 28, 1921	11	S. I. 33	do	1.0056
Oct. 1, 1921	10	do	do	1.0112
July 18, 1921	10	S. I. 34	do	1.0102
Aug. 30, 1921	11	do	do	1.0198
July 18, 1921	10	S. I. 35	do	1.0403
Aug. 21, 1921	10	do	do	1.0355
May 19, 1922	9	S. I. 36	do	1.0382
May 20, 1922	9	do	do	1.0411
May 19, 1922	9	S. I. 37	S. I. 5	1.0050
May 20, 1922	9	do	do	1.0080
Nov. 9–19, 1923	12	S. I. 38	A. P. O. 8_{bis}	1.0160
Feb. 7, 1929	6	do	S. I. 17	[5] 0.9956

[1] Smoky sky. Found mercury seal defective.
[2] S. I. 1 was repaired and had new 12½-inch vestibule.
[3] New 12½-inch vestibule on A. P. O. $8_{bis\ bis}$.
[4] New thermometer and vestibule on S. I. 16.
[5] At this time S. I. 17 had temporary blackening, and its constant was 0.3674.

[a] See also Smithsonian Pyrheliometry Revised, Smithsonian Miscellaneous Collections, vol. 60, no. 18 for earlier comparisons.

TABLE 24.—*Comparisons of pyrheliometers. General*—Continued

Date	Number of comparisons	Pyrheliometers used		Ratio A/B
		A	B	
Nov. 9–19, 1923	16	S. I. 39	A. P. O. 8_{bis}	1. 0057
Nov. 13, 1923	8	S. I. 40	do	1. 0659
Nov. 19, 1923	8	do	do	1. 0655
Dec. 7, 1923	9	S. I. 41	do	1. 0392
Jan. 25, 1927	8	S. I. 41_{bis}	S. I. 5	[6] 0. 9918
Feb. 17, 1927	6	do	do	0. 9885
Mar. 10, 1927	8	do	do	0. 9889
Mar. 16, 1927	8	do	do	0. 9895
Nov. 5, 1929	8	do	A. P. O. $8_{bis\ bis}$	1. 0265
Nov. 6, 1929	8	do	do	1. 0242
Dec. 9, 1924	8	S. I. 43	S. I. 5	0. 9781
Dec. 13, 1924	8	do	A. P. O. 8_{bis}	1. 0185
Dec. 9, 1924	9	S. I. 44	do	1. 0217
Dec. 13, 1924	8	do	S. I. 5	0. 9875
Dec. 3, 1928	8	S. I. 44_{bis}	A. P. O. $8_{bis\ bis}$	[7] 0. 9989
Dec. 5, 1928	8	do	do	0. 9936
Do	8	do	S. I. 5	0. 9716
July 29, 1925	15	S. I. 45	A. P. O. 8_{bis}	1. 0363
Oct. 7, 1925	15	do	do	1. 0306
July 18, 1925	6	S. I. 46	S. I. 5	0. 9903
July 29, 1925	14	do	do	0. 9928
Oct. 7, 1925	8	do	do	0. 9923
Oct. 8, 1925	8	do	A. P. O. 8_{bis}	1. 0214
Oct. 10, 1925	8	do	do	1. 0173
Mar. 22, 1926	7	S. I. 47	do	1. 0017
Apr. 9, 1926	8	do	S. I. 5	0. 9669
Mar. 22, 1926	8	S. I. 48	do	0. 9488
Apr. 9, 1926	8	do	do	0. 9840
Dec. 30, 1926	8	S. I. 49	do	1. 0219
Jan. 11, 1927	8	do	A. P. O. 8_{bis}	1. 0579
Jan. 25, 1927	8	S. I. 50	do	1. 0102
Jan. 27, 1927	8	do	S. I. 5	0. 9815
Feb. 17, 1927	6	do	A. P. O. 8_{bis}	1. 0148
Mar. 10, 1927	7	do	do	1. 0160
Mar. 16, 1927	8	do	do	1. 0221
Apr. 11, 1927	8	do	do	1. 0131
Dec. 30, 1926	8	S. I. 51	do	1. 0112
Jan. 11, 1927	8	do	S. I. 5	0. 9765
Jan. 27, 1927	8	do	A. P. O. 8_{bis}	1. 0071
Aug. 16, 1927	8	S. I. 52	S. I. 5	0. 9681
Aug. 30, 1927	8	do	A. P. O. 8_{bis}	[8] 1. 0012
Sept. 5, 1927	8	do	do	1. 0024
Sept. 6, 1927	8	do	S. I. 5	0. 9665

[6] S. I. 41 had new thermometer inserted, replacing broken one. Also new 12½-inch vestibule.
[7] S. I. 44 had new thermometer and new 12½-inch vestibule.
[8] Sky very hazy.

TABLE 24.—*Comparisons of pyrheliometers. General*—Continued

Date	Number of comparisons	Pyrheliometers used		Ratio A/B
		A	B	
Nov. 13, 1927	10	S. I. 53	A. P. O. 8_{bis}	0. 9911
Nov. 14, 1927	5	do	do	0. 9916
Dec. 5, 1927	8	do	S. I. 5	0. 9628
Dec. 9, 1927	8	do	do	0. 9658
Nov. 14, 1927	8	S. I. 54	do	0. 9556
Nov. 19–26, 1927	19	do	do	0. 9575
Dec. 5, 1927	8	do	A. P. O. $8_{bis\ bis}$	0. 9933
Dec. 9, 1927	8	do	do	0. 9891
Apr. 5, 1928	8	S. I. 55	do	0. 9818
Apr. 13, 1928	8	do	do	0. 9837
Apr. 18, 1928	8	do	do	0. 9861
Aug. 14, 1928	8	S. I. 56	do	[9] 1. 0127
Sept. 10, 1928	8	do	A. P. O. 8_{bis}	[10] 1. 0169
Sept. 11, 1928	8	do	do	[11] 1. 0073
Sept. 22, 1928	8	do	do	[12] 1. 0102
May 10, 1929	6	S. I. 57	do	0. 9942
May 17, 1929	8	do	do	0. 9946
May 10, 1929	6	do	S. I. 5	0. 9564
July 27, 1929	8	S. I. 16_{bis}	A. P. O. $8_{bis\ bis}$	[13] 1. 0359
Sept. 7, 1929	8	S. I. 58	do	0. 9893
Sept. 10, 1929	3	do	do	0. 9874
Sept. 11, 1929	8	do	do	0. 9876
Jan. 9, 1930	8	S. I. 59	do	[14] 0. 9788
Feb. 3, 1930	8	do	do	0. 9852
Feb. 10, 1930	7	do	do	0. 9828
Nov. 21–23, 1921	22	S. I. 30	S. I. 5	[15] 0. 9997
Nov. 9, 1923	12	A. P. O. 10	A. P. O. 8_{bis}	1. 0177
Oct. 8, 1925	8	A. P. O. 11	S. I. 5	1. 0080
Oct. 10, 1925	8	do	do	1. 0076
Oct. 20, 1925	8	do	A. P. O. 8_{bis}	1. 0382
Apr. 13, 1928	8	A. P. O. 9_{bis}	S. I. 5	[16] 0. 9983
Apr. 18, 1928	8	do	A. P. O. $8_{bis\ bis}$	1. 0257
October, 1928		A. P. O. 12		([17])

[9] Poor sky.
[10] Hazy.
[11] Better sky.
[12] Fluctuating sky.
[13] New thermometer and 12½-inch vestibule in S. I. 16_{bis}.
[14] Observations one-half minute apart.
[15] Comparison by C. G. A. and L. H. A. at Montezuma. See also $\frac{\text{S. I. 5}}{\text{A. P. O. }8_{bis}}$ at Washington before and after.
[16] A. P. O. 9 had thermometer reinserted and new 12½-inch vestibule.
[17] A. P. O. 12 was not compared in Washington, but its constant was determined at Table Mountain from A. P. O. 10, S. I. 32, and S. I. 42. See following table.

TABLE 25.—*Present adopted constants and location of silver-disk pyrheliometers* [1]

Instrument	Constant [2]	Where sent
S. I. 33	0. 3755	Royal Observatory of Capodimonte, Naples, Italy.
S. I. 34	. 3730	Riverview College Observatory, Sydney, Australia.
S. I. 35	. 3648	Do.
S. I. 36	. 3640	Central Meteorological Institute, Bucharest, Rumania.
S. I. 37	. 3648	University of Lemberg and Warsaw, Lemberg, Poland.
S. I. 38	. 3726	Argentine Meteorological Service, observatory at La Quiaca, Argentina.
S. I. 39	. 3764	Do.
S. I. 40	. 3553	Institut de Physique du Globe, Paris, France.
S. I. 41	. 3643	Observatory on Zugspitze, Munich, Germany.
S. I. 41_{bis}	. 3679	Observatory on Zugspitze, Munich, Germany, and (1929) National Research Institute, Nanking, China.
S. I. 42	. 3624	Mount Harqua Hala, Ariz., and Table Mountain, Calif.
S. I. 43	. 3735	Stellenbosch University, Union of South Africa.
S. I. 44	. 3712	Meteorological Service, Rio de Janeiro, Brazil.
S. I. 44_{bis}	. 3793	Do.
S. I. 45	. 3658	University of Aberdeen, Scotland.
S. I. 46	. 3705	Meteorological Bureau, Riga, Latvia.
S. I. 47	. 3790	Mount Brukkaros, Southwest Africa.
S. I. 48	. 3859	Do.
S. I. 49	. 3586	Battle Creek College, Mich.
S. I. 50	. 3730	Observatory, Davos, Switzerland.
S. I. 51	. 3755	Meteorological Service, British India.
S. I. 52	. 3787	University Observatory, Kiel, Germany.
S. I. 53	. 3802	Commonwealth Solar Observatory, Canberra, Australia.
S. I. 54	. 3825	Do.
S. I. 55	. 3848	University of Illinois, Dept. of Botany, Urbana, Ill.
S. I. 56	. 3742	University Observatory, Kiel, Germany.
S. I. 57	. 3818	General Meteorological Service, Rabat, Morocco.
S. I. 58	. 3831	Oporto Observatory, Portugal.
S. I. 59	. 3851	University of Arizona, Tucson, Ariz.
S. I. 1_{bis}	. 3728	U. S. Weather Bureau, Washington, D. C.
S. I. 16_{bis}	. 3655	University of Arizona, Tucson, Ariz.
A. P. O. $8_{bis\ bis}$	. 3786	Astrophysical Observatory, Washington, D. C.
A. P. O. 9_{bis}	. 3684	Zentralanstalt f. Meteorologie u. Geodynamik, Vienna, Austria.
A. P. O. 10	. 3719	Mount Harqua Hala, Ariz., and Table Mountain, Calif.
A. P. O. 11	. 3645	Mount Brukkaros, Southwest Africa.
A. P. O. 12	. 3618	Table Mountain, Calif.

[1] For other instruments, see Annals IV, Table 14.
[2] These values are the factors by which the corrected temperature rise in 100 seconds is to be multiplied to reduce the readings to calories (15° C.) per sq. cm per min.

PYRANOMETRY

We employ the pyranometer in our daily solar-constant observations at our several field stations, and we have furnished a few of these instruments to observers in various lands. We are accustomed to compute a constant for the pyranometer from the dimensions of its strip and electrical resistance and the absorption of its parts. But as the accuracy to be reached in this way is not high, we prefer to standardize the pyranometer against the pyrheliometer by solar observations. For if both instruments are exposed simultaneously at right angles to the solar beam, restricting the exposure of the pyranometer to the sun and its immediately surrounding sky, the constant of the pyranometer is given by the expression $K=\frac{QR}{C^2}$ in which Q is the constant and R the corrected reading of the pyrheliometer, and C^2 is the mean of the squares of current strength employed in the pyranometer during the solar exposure to effect a balance with solar heating.

TABLE 26.—*Comparisons, adopted constants, and locations of pyranometers*

Date	Number of comparisons	Instruments used		Pyranometer constant accepted	Where located
		Pyranometer	Pyrheliometer		
Feb. 6, 1917	18	S. I. 1	S. I. 1 and 2	3. 02	University of Wisconsin.
Do	15	S. I. 2	A. P. O. 8_{bis} and S. I. 5.	2. 206	U. S. Weather Bureau.
Aug. 26, 1917	17	S. I. 3	S. I. 29	2. 083	Hump Mountain, N. C., and Montezuma, Chile.
Nov. 13, 1920	11	S. I. 4	A. P. O. 8_{bis}	20. 90	U. S. Department of Agriculture, Plant Industry.
1921 and 1923	[1] 19	S. I. 5	A. P. O. 9 and S. I. 32.	15. 10	Table Mountain, Calif.
1924	9	do	do	15. 24	Do.
1926	4	do	A. P. O. 10 and S. I. 32.	15. 05	Do.
1926 and 1927	8	do	do	15. 01	Do.
1927 and 1928	12	do	do	15. 10	Do.
1929	3	do	do	15. 03	Do.
Sept. 19, 1921	15	S. I. 6	A. P. O. 8_{bis}	14. 76	Riverside Observatory Sydney, Australia.
May 19, 1924		S. I. 7		16. 50	Institut de Physique du Globe, Paris, France.
Feb. 24, 1926	14	S. I. 8	S. I. 5	17. 09	Smithsonian Institution.
April, 1926		S. I. 9	Arrived broken; repaired in 1930.		Mount Brukkaros, Southwest Africa.
Feb. 3, 1927	10	S. I. 10	S. I. 47 and 48	24. 18	Do.
May 16, 1927	10	do	do	24. 69	Do.
May 31, 1927	10	do	do	24. 18	Do.
Aug. 3, 1927	10	do	do	24. 57	Do.
Dec. 30, 1927	10	do	do	24. 21	Do.
Feb. 8, 1928	10	do	do	24. 36	Do.
Jan. 11, 1930		do	do	24. 64	Do.
Jan. 2, 3, and 4, 1928	16	S. I. 11	A. P. O. 8_{bis}	6. 18	Commonwealth Observatory, Canberra, Australia.
Apr. 2 and 19, 1929	12	S. I. 12	do	24. 38	Wellesley College, Mass. (Department of Botany).

[1] This and following numbers relating to S. I. 5 are numbers of days on which comparisons were made.

TABLE 26.—*Comparisons, adopted constants, and locations of pyranometers*—Continued

Date	Number of comparisons	Instruments used		Pyranometer constant accepted	Where located
		Pyranometer	Pyrheliometer		
June 19 and 23, 1930	15	S. I. 13	A. P. O. 8_{bis}	26. 36	Carnegie Institution, Ecological Research, Tucson, Ariz.
Dec. 1, 1921	6	A. P. O. 7	S. I. 29	13. 95	Montezuma, Chile.
April 26, 1924	4	do	S. I. 30	13. 72	Do.
June 17 and July 15, 1924.	4	do	S. I. 29 and 30	13. 58	Do.
Nov. 6, 1924		do	do	13. 52	Do.
Mar. 23, 1925		do	do	13. 60	Do.
Oct. 12, 1926		do	do	(13. 55)	Do.
Jan. 6, 1927		do	do	13. 62	Do.
June 23, 1927	10	do	do	13. 52	Do.
July 16, 1927		do	do	13. 65	Do.
Aug. 4, 1927		do	do	13. 61	Do.
Mar. 12, 1928	10	do	do	13. 35	Do.
May 5, 1928	10	do	do	13. 42	Do.
July 6, 1928	10	do	do	13. 41	Do.
July 5, 1929	10	do	do	13. 84	Do.
Apr. 22, 1930	8	do	do	13. 47	Do.
Aug. 23, 1930	10	do	do	13. 68	Do.

PYRHELIOMETRIC OBSERVATIONS

Limitations of cost prevent us from publishing all of the pyrheliometric observations made at the several stations. We continue here only the table of them for Montezuma, Chile, of which the results of the years August, 1920, to April, 1926, inclusive, were published by the United States Weather Bureau under the title Montezuma Pyrheliometry, Monthly Weather Review, Supplement No. 27, issued December, 1926.

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multipy R by 0.3629]

1926	
M.	R.
May 1, a. m.	
2.82	3.830
2.51	3.926
2.20	4.025
2.00	4.104
1.80	4.167
May 2, a. m.	
2.20	4.014
2.00	4.092
1.81	4.177
1.61	4.246
1.50	4.317
May 3, a. m.	
2.52	3.837
2.19	3.964
2.01	4.038
1.80	4.129
1.60	4.220
May 4, a. m.	
2.48	3.869
2.20	3.963
2.00	4.055
1.45	4.264
1.40	4.281
May 5, a. m.	
2.81	3.597
2.49	3.698
2.20	3.813
2.00	3.892
1.81	3.963
May 6, a. m.	
4.77	3.174
3.91	3.394
3.03	3.644
2.51	3.791
2.00	4.033
1.50	4.232
May 7, a. m.	
2.79	3.802
2.45	3.905
2.19	3.997
1.99	4.079
1.79	4.151
May 8, a. m.	
2.81	3.828
2.50	3.926
2.20	4.025
2.01	4.093
1.82	4.168
May 9, a. m.	
2.70	3.781
2.20	3.927
2.00	4.015
1.81	4.073
1.61	4.170

1926	
M.	R.
May 10, a. m.	
2.18	4.055
2.00	4.111
May 11, a. m.	
2.81	3.681
2.19	3.877
2.00	3.936
1.81	3.999
May 12, a. m.	
2.80	3.649
2.51	3.726
2.21	3.836
2.00	3.920
1.80	4.002
May 13, a. m.	
1.70	4.183
1.60	4.220
1.50	4.251
1.46	4.285
1.41	4.306
May 14, a. m.	
2.50	3.938
2.20	4.014
2.01	4.105
1.82	4.198
1.51	4.266
May 15, a. m.	
2.82	3.819
2.52	3.908
2.20	4.020
2.00	4.103
1.81	4.179
May 18, a. m.	
2.50	3.846
2.19	3.959
2.00	4.028
1.81	4.111
1.61	4.193
May 19, a. m.	
2.20	3.980
2.00	4.046
1.80	4.116
1.60	4.199
1.50	4.238
May 20, a. m.	
2.82	3.787
2.51	3.876
2.20	3.983
2.00	4.055
1.80	4.140

1926	
M.	R.
May 21, a. m.	
2.81	3.796
2.50	3.895
2.20	3.995
2.00	4.060
1.60	4.227
May 22, a. m.	
2.83	3.790
2.50	3.888
2.20	3.983
2.00	4.055
1.60	4.195
May 24, a. m.	
2.80	3.802
2.50	3.890
2.20	3.986
2.00	4.028
1.80	4.107
May 25, a. m.	
2.00	4.044
1.81	4.111
1.60	4.181
1.50	4.216
1.43	4.239
May 26, a. m.	
2.80	3.732
2.26	3.936
2.00	3.968
1.80	4.023
1.60	4.135
May 27, a. m.	
5.00	3.170
4.02	3.403
3.03	3.652
2.50	3.831
2.00	3.981
1.50	4.187
May 28, a. m.	
2.52	3.931
2.20	4.032
2.00	4.105
1.80	4.183
1.60	4.246
June 1, a. m.	
1.70	4.174
June 3, a. m.	
2.81	3.832
2.50	3.926
2.20	4.016
2.00	4.094
1.61	4.254

1926	
M.	R.
June 4, a. m.	
1.55	4.140
1.50	4.160
1.47	4.201
June 6, a. m.	
1.60	4.224
1.56	4.235
1.52	4.244
1.50	4.248
1.46	4.258
June 8, a. m.	
1.60	4.134
1.56	4.130
1.52	4.168
1.50	4.172
1.46	4.200
June 11, a. m.	
2.19	3.892
2.00	3.971
1.81	4.047
1.60	4.147
1.51	4.181
June 12, a. m.	
2.82	3.714
2.50	3.810
2.20	3.910
2.00	3.981
1.81	4.056
June 13, a. m.	
2.00	3.999
1.80	4.060
1.70	4.116
1.61	4.150
1.50	4.188
June 14, a. m.	
2.20	4.027
2.00	4.076
1.80	4.155
1.70	4.188
1.61	4.227
June 15, a. m.	
2.47	3.929
2.00	4.089
1.79	4.177
1.60	4.246
1.50	4.285
June 16, a. m.	
2.51	3.981
2.00	4.139
1.80	4.198
1.60	4.262
1.50	4.295

1926	
M.	R.
June 17, a. m.	
2.81	3.767
2.50	3.882
2.20	3.956
2.00	4.041
1.48	4.215
June 18, a. m.	
2.70	3.864
2.50	3.910
2.20	4.033
2.00	4.083
1.47	4.300
June 19, a. m.	
2.49	3.916
2.21	3.981
2.00	4.044
1.91	4.093
1.80	4.133
June 23, a. m.	
2.82	3.552
2.50	3.664
2.20	3.798
2.00	3.882
June 24, a. m.	
2.80	3.587
2.50	3.686
2.20	3.802
2.00	3.882
1.80	3.963
June 25, a. m.	
2.80	3.681
2.50	3.776
2.20	3.868
2.00	3.945
1.80	4.011
June 26, a. m.	
2.80	3.793
2.50	3.880
2.20	3.995
2.00	4.069
1.80	4.153
June 27, a. m.	
1.50	4.155
1.47	4.175
1.45	4.163
1.45	4.177
June 29, a. m.	
4.50	3.066
3.69	3.293
3.03	3.487
2.50	3.653
2.00	3.819

1926	
M.	R.
July 1, a. m.	
2.82	3.614
2.50	3.702
2.21	3.830
2.00	3.922
1.80	4.009
July 2, a. m.	
2.80	3.743
1.78	4.098
1.69	4.132
1.57	4.185
1.50	4.256
July 3, a. m.	
2.50	3.938
2.20	4.041
2.00	4.076
1.79	4.171
1.60	4.254
July 4, a. m.	
2.80	3.871
2.20	4.068
1.97	4.140
1.80	4.247
1.60	4.316
July 5, a. m.	
5.00	3.355
4.01	3.565
2.99	3.873
2.50	3.990
2.00	4.130
1.50	4.345
July 6, a. m.	
2.82	3.882
2.50	3.963
2.20	4.043
2.00	4.140
1.80	4.198
July 7, a. m.	
2.50	3.983
2.20	3.999
2.00	4.065
1.90	4.110
1.80	4.148
July 8, a. m.	
2.80	3.771
2.51	3.868
2.20	3.971
2.00	4.053
1.80	4.150
July 9, a. m.	
2.51	3.895
2.20	3.988
2.00	4.043
1.80	4.111
1.50	4.219

1926	
M.	R.
July 10, a. m.	
2.81	3.795
2.51	3.890
2.21	3.999
1.90	4.121
1.80	4.159
July 11, a. m.	
2.50	3.835
2.20	3.923
2.00	3.983
1.60	4.145
1.50	4.176
July 12, a. m.	
2.82	3.685
2.51	3.785
2.21	3.882
2.00	3.968
1.80	4.050
July 13, a. m.	
5.04	3.181
4.03	3.400
3.00	3.639
2.51	3.789
2.00	3.960
1.50	4.137
July 15, a. m.	
2.80	3.799
2.19	3.998
1.81	4.140
1.60	4.224
1.50	4.260
July 16, a. m.	
1.45	4.310
1.40	4.338
July 17, a. m.	
2.80	3.872
2.21	4.052
2.00	4.125
1.90	4.168
1.80	4.210
July 18, a. m.	
2.50	3.999
2.20	4.093
2.00	4.155
1.81	4.241
1.60	4.315
July 19, a. m.	
2.79	3.626
2.51	3.715
2.20	3.833
2.00	3.895
1.79	3.965

Table 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1926 M.	R.
July 20, a. m.	
2.80	3.643
2.50	3.750
2.20	3.833
2.00	3.945
1.80	4.051
July 21, a. m.	
2.80	3.707
2.20	3.890
2.00	3.986
1.60	4.145
1.50	4.183
July 22, a. m.	
5.00	3.233
4.00	3.477
2.99	3.741
2.51	3.886
1.99	4.074
1.50	4.240
July 23, a. m.	
2.82	3.837
2.51	3.917
2.20	4.046
2.00	4.093
1.50	4.296
July 24, a. m.	
2.80	3.859
2.50	3.955
2.19	4.055
2.00	4.111
1.80	4.178
July 25, a. m.	
2.20	4.024
1.96	4.123
1.67	4.240
1.54	4.295
July 26, a. m.	
2.79	3.854
2.19	4.054
1.92	4.156
1.74	4.225
1.60	4.271
July 27, a. m.	
2.50	4.024
2.15	4.126
1.92	4.190
1.70	4.264
1.56	4.331
July 28, a. m.	
2.50	4.001
2.20	4.107
2.00	4.188
1.80	4.271
1.60	4.324

1926 M.	R.
July 29, a. m.	
2.49	3.875
2.19	3.995
2.00	4.074
1.80	4.135
1.60	4.198
July 30, a. m.	
2.80	3.873
2.50	3.963
2.20	4.055
2.00	4.126
1.48	4.322
July 31, a. m.	
2.80	3.902
2.50	4.004
2.20	4.111
2.00	4.183
1.80	4.259
Aug. 1, a. m.	
2.50	3.926
2.18	4.027
2.00	4.095
1.80	4.174
1.60	4.236
Aug. 2, a. m.	
2.82	3.813
2.50	3.908
2.19	4.018
2.00	4.074
1.38	4.319
Aug. 3, a. m.	
2.82	3.800
2.51	3.889
2.19	4.004
2.00	4.074
1.48	4.262
Aug. 4, a. m.	
2.78	3.882
2.49	3.978
2.20	4.065
2.00	4.135
1.70	4.246
Aug. 5, a. m.	
2.82	3.771
2.50	3.881
2.21	3.990
2.00	4.060
1.47	4.266
Aug. 6, a. m.	
4.96	3.461
4.00	3.656
3.01	3.921
2.50	4.064
2.00	4.219
1.50	4.367

1926 M.	R.
Aug. 7, a. m.	
2.48	3.606
Aug. 9, a. m.	
1.80	3.994
1.69	4.020
Aug. 10, a. m.	
2.20	3.808
2.00	3.890
1.80	3 963
1.60	4.050
1.50	4.093
Aug. 11, a. m.	
2.76	3.548
2.20	3.770
2.00	3.855
1.90	3.899
1.80	3.939
Aug. 15, a. m.	
2.80	3.926
2.51	4.002
2.19	4.102
2.00	4.178
1.60	4.316
Aug. 16, a. m.	
2.78	3.888
2.51	3.964
2.21	4.055
2.00	4.119
1.80	4.203
Aug. 24, a. m.	
1.30	4.373
1.26	4.396
1.22	4.416
Aug. 25, a. m.	
2.80	3.886
2.50	3.972
2.20	4.083
1.99	4.161
1.80	4.213
Aug. 26, a. m.	
2.81	3.901
2.52	3.990
2.21	4.078
2.00	4.144
1.60	4.315
Aug. 27, a. m.	
2.80	3.917
2.51	4.018
2.20	4.126
2.00	4.188
1.60	4.354

1926 M.	R.
Aug. 28, a. m.	
2.50	4.023
2.19	4.114
2.00	4.178
1.60	4.320
1.50	4.394
Aug. 29, a. m.	
2.79	3.882
2.51	3.990
2.20	4.130
2.00	4.190
1.60	4.308
Aug. 30, a. m.	
1.19	4.324
1.18	4.356
Aug. 31, a. m.	
4.74	3.218
3.80	3.436
2.95	3.667
2.51	3.819
2.00	4.010
1.50	4.217
Sept. 1, a. m.	
1.97	4.076
1.71	4.183
1.50	4.262
1.38	4.312
1.29	4.345
Sept. 2, a. m.	
1.88	4.126
1.66	4.227
1.52	4.287
1.40	4.332
1.33	4.365
Sept. 3, a. m.	
2.50	3.821
2.10	3.981
1.78	4.100
1.61	4.169
1.46	4.227
Sept. 4, a. m.	
2.48	3.920
2.06	4.075
1.78	4.198
1.60	4.281
1.45	4.338
Sept. 5, a. m.	
2.21	4.104
1.90	4.213
1.67	4.302
1.54	4.355
1.40	4.417

1926 M.	R.
Sept. 6, a. m.	
2.44	4.004
2.05	4.162
1.80	4.261
1.48	4.390
Sept. 7, a. m.	
2.43	3.976
2.02	4.123
1.78	4.217
1.60	4.286
1.48	4.338
Sept. 8, a. m.	
2.52	3.939
2.01	4.116
1.70	4.254
1.54	4.325
1.42	4.372
Sept. 9, a. m.	
2.04	4.121
1.80	4.215
1.59	4.289
1.44	4.349
1.35	4.387
Sept. 11, a. m.	
1.20	4.414
1.17	4.426
Sept. 12, a. m.	
1.64	4.053
1.45	4.130
1.33	4.190
1.25	4.229
Sept. 13, a. m.	
2.20	4.029
2.70	4.063
2.60	4.071
1.50	4.118
1.44	4.129
Sept. 18, a. m.	
2.20	3.931
2.00	4.004
1.80	4.079
1.60	4.156
1.50	4.194
Sept. 19, a. m.	
2.42	3.963
2.02	4.116
1.71	4.239
1.54	4.307
1.41	4.365

1926 M.	R.
Sept. 20, a. m.	
2.50	3.960
2.10	4.102
1.78	4.233
1.60	4.315
1.46	4.367
Sept. 21, a. m.	
2.67	3.931
2.20	4.093
1.91	4.194
1.70	4.271
1.50	4.345
Sept. 22, a. m.	
2.80	3.928
2.31	4.074
1.99	4.167
1.70	4.251
1.55	4.300
Sept. 23, a. m.	
2.82	3.945
2.31	4.109
1.99	4.215
1.79	4.283
1.60	4.347
Sept. 24, a. m.	
2.51	3.999
2.15	4.102
1.88	4.203
1.69	4.276
1.53	4.355
Sept. 26, a. m.	
1.50	4.428
1.40	4.451
1.32	4.482
Sept. 27, a. m.	
2.70	3.999
2.20	4.162
1.91	4.259
1.71	4.340
1.55	4.395
Sept. 28, a. m.	
2.81	4.018
2.34	4.159
2.00	4.278
1.80	4.346
1.60	4.421
Sept. 29, a. m.	
1.70	4.185
1.55	4.252
1.42	4.312
1.35	4.348

1926 M.	R.
Oct. 1, a. m.	
2.71	3.873
2.31	4.004
1.98	4.135
1.70	4.271
1.51	4.347
Oct. 2, a. m.	
2.80	3.895
2.37	4.036
2.00	4.178
1.79	4.266
1.60	4.340
Oct. 3, a. m.	
2.19	4.093
2.00	4.164
1.80	4.241
1.59	4.325
1.50	4.360
Oct. 4, a. m.	
2.79	3.467
2.46	3.606
2.19	3.696
1.60	3.957
1.50	3.990
Oct. 5, a. m.	
1.38	4.112
1.33	4.161
1.28	4.173
Oct. 7, a. m.	
1.99	3.896
1.78	3.977
1.59	4.061
1.50	4.105
1.43	4.154
Oct. 8, a. m.	
1.54	4.074
1.47	4.107
1.41	4.121
1.36	4.139
1.30	4.169
Oct. 9, a. m.	
4.93	3.241
3.96	3.479
2.98	3.789
2.48	3.936
2.00	4.097
1.50	4.321
Oct. 10, a. m.	
2.50	4.061
2.20	4.164
2.00	4.227
1.80	4.300
1.60	4.375

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1926	
M.	R.
Oct. 11, a. m.	
2.80	3.956
2.50	4.034
2.20	4.120
2.01	4.207
1.60	4.379
Oct. 12, a. m.	
2.83	3.864
2.52	3.963
2.21	4.091
2.00	4.174
1.80	4.261
Oct. 13, a. m.	
2.70	3.986
2.30	4.121
2.00	4.230
1.80	4.305
1.60	4.385
Oct. 14, a. m.	
2.80	3.986
2.50	4.060
2.20	4.162
2.00	4.217
1.60	4.379
Oct. 15, a. m.	
4.25	3.517
3.61	3.750
3.00	3.906
2.50	4.059
2.00	4.236
1.50	4.427
Oct. 16, a. m.	
2.49	3.980
2.20	4.074
2.00	4.151
1.82	4.239
1.61	4.308
Oct. 17, a. m.	
2.51	4.074
2.19	4.214
2.00	4.266
1.80	4.362
1.60	4.424
Oct. 18, a. m.	
2.50	4.098
2.20	4.222
2.01	4.276
1.80	4.355
1.60	4.424
Oct. 19, a. m.	
4.93	3.420
3.96	3.680
2.99	3.963
2.51	4.091
2.00	4.311
1.50	4.513

1926	
M.	R.
Oct. 20, a. m.	
2.80	4.023
2.52	4.102
2.20	4.193
2.00	4.285
1.60	4.434
Oct. 21, a. m.	
2.80	3.943
2.50	4.038
2.20	4.169
2.00	4.244
1.60	4.426
Oct. 22, a. m.	
2.80	3.991
2.50	4.103
2.20	4.243
2.00	4.320
1.60	4.472
Oct. 23, a. m.	
2.50	4.121
2.19	4.227
2.00	4.295
1.80	4.365
1.60	4.428
Oct. 24, a. m.	
1.71	4.339
1.59	4.393
1.48	4.447
Oct. 25, a. m.	
1.91	4.181
1.70	4.238
1.61	4.281
1.50	4.333
1.43	4.369
Oct. 26, a. m.	
1.45	4.408
1.39	4.420
1.33	4.440
1.29	4.458
1.25	4.492
Oct. 27, a. m.	
2.82	3.895
2.50	4.012
2.19	4.130
2.00	4.203
1.81	4.285
Oct. 28, a. m.	
1.70	4.297
1.60	4.339
1.50	4.379
1.43	4.431
1.35	4.457

1926	
M.	R.
Oct. 29, a. m.	
2.32	3.963
2.00	4.111
1.81	4.194
1.61	4.300
1.51	4.340
Oct. 31, a. m.	
1.70	4.073
1.60	4.143
1.50	4.204
1.43	4.200
1.36	4.207
Nov. 1, a. m.	
2.79	3.806
2.51	3.940
2.19	4.041
2.01	4.130
1.60	4.203
Nov. 2, a. m.	
4.57	3.560
3.74	3.762
2.99	3.986
2.52	4.130
2.00	4.297
1.50	4.491
Nov. 3, a. m.	
2.50	4.018
2.18	4.116
2.01	4.188
1.80	4.266
1.60	4.355
Nov. 4, a. m.	
2.80	3.945
2.51	4.034
2.21	4.153
2.00	4.234
1.60	4.402
Nov. 5, a. m.	
2.51	4.061
2.20	4.191
2.00	4.229
1.80	4.323
1.60	4.410
Nov. 6, a. m.	
1.24	4.596
1.20	4.628
1.19	4.631
Nov. 7, a. m.	
2.82	4.011
2.52	4.099
2.20	4.200
Nov. 8, a. m.	
1.35	4.528
1.31	4.518
1.25	4.535
1.22	4.560
1.18	4.572

1926	
M.	R.
Nov. 10, a. m.	
2.80	3.904
2.50	4.014
2.19	4.130
2.01	4.203
1.82	4.281
Nov. 11, a. m.	
2.85	3.864
2.52	3.994
2.20	4.098
2.00	4.155
1.60	4.352
Nov. 12, a. m.	
2.97	3.497
2.49	3.696
1.90	3.948
Nov. 13, a. m.	
2.77	3.627
2.48	3.726
2.19	3.868
1.99	3.945
1.61	4.129
Nov. 14, a. m.	
2.20	4.017
2.00	4.084
1.80	4.186
1.60	4.254
1.50	4.310
Nov. 15, a. m.	
1.19	4.431
1.15	4.433
1.13	4.425
Nov. 16, a. m.	
2.22	3.936
2.00	4.039
1.81	4.133
1.58	4.247
1.50	4.295
Nov. 17, a. m.	
2.80	3.554
2.51	3.664
2.21	3.779
2.00	3.893
1.80	3.977
Nov. 19, a. m.	
1.28	4.352
1.24	4.354
1.20	4.380
1.17	4.394
Nov. 20, a. m.	
2.20	3.917
1.99	4.022
1.80	4.064
1.60	4.178
1.49	4.251

1926	
M.	R.
Nov. 24, a. m.	
2.82	3.622
2.52	3.696
2.21	3.830
1.99	3.922
1.60	4.133
Nov. 25, a. m.	
4.90	2.864
3.98	3.126
3.01	3.451
2.50	3.626
1.99	3.885
1.49	4.138
Nov. 27, a. m.	
2.32	4.005
2.09	4.033
Nov. 29, a. m.	
2.80	3.950
Nov. 30, a. m.	
1.13	4.677
1.10	4.704
Dec. 3, a. m.	
1.21	4.280
1.17	4.308
1.13	4.337
1.11	4.336
1.09	4.358
Dec. 9, a. m.	
2.31	3.971
1.99	4.102
1.81	4.188
1.60	4.283
1.51	4.320
Dec. 10, a. m.	
2.80	3.853
2.52	3.963
2.21	4.091
1.99	4.180
1.60	4.363
Dec. 11, a. m.	
2.80	3.864
2.50	3.973
2.20	4.083
2.01	4.163
1.60	4.170
Dec. 12, a. m.	
2.31	3.873
2.00	4.020
1.79	4.085
1.62	4.227
1.50	4.266

1926	
M.	R.
Dec. 13, a. m.	
2.51	4.031
2.20	4.135
2.00	4.222
1.80	4.300
1.60	4.373
Dec. 14, a. m.	
2.45	4.067
2.01	4.247
1.70	4.387
1.47	4.499
1.35	4.558
Dec. 15, a. m.	
2.50	4.100
2.00	4.305
1.70	4.433
1.50	4.529
1.36	4.612
Dec. 16, a. m.	
2.31	4.064
2.00	4.209
1.81	4.305
1.60	4.390
1.50	4.436
Dec. 18, a. m.	
1.47	4.425
1.40	4.457
1.35	4.480
1.30	4.504
1.26	4.520
Dec. 19, a. m.	
1.03	4.582
Dec. 20, a. m.	
2.80	3.857
2.51	3.972
2.20	4.095
1.99	4.179
1.51	4.390
Dec. 24, a. m.	
1.70	4.408
1.61	4.445
1.50	4.487
1.43	4.515
1.37	4.537
Dec. 25, a. m.	
1.09	4.681
1.06	4.675
1.05	4.680
1.04	4.650
Dec. 27, a. m.	
1.04	4.604
1.03	4.584

1926	
M.	R.
Dec. 28, a. m.	
1.05	4.532
1.04	4.526
1.04	4.522
1927	
M.	R.
Jan. 1, a. m.	
1.44	4.303
1.38	4.337
1.34	4.365
1.29	4.362
1.24	4.367
Jan. 2, a. m.	
2.50	3.855
2.20	3.967
2.00	4.038
1.80	4.148
1.61	4.246
Jan. 3, a. m.	
2.20	3.906
2.00	4.005
1.82	4.097
1.61	4.212
1.50	4.278
Jan. 4, a. m.	
4.90	3.049
3.95	3.311
3.02	3.591
2.52	3.800
1.99	4.030
1.50	4.254
Jan. 5, a. m.	
2.78	3.819
2.51	3.890
2.20	4.031
2.01	4.098
1.81	4.206
Jan. 6, a. m.	
2.80	3.843
2.50	3.958
2.18	4.081
2.00	4.156
1.79	4.246
Jan. 7, a. m.	
2.78	3.851
2.51	3.952
1.99	4.148
1.80	4.218
1.61	4.294
Jan. 8, a. m.	
2.80	3.698
2.52	3.802
2.20	3.924
2.00	3.999
1.60	4.180

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1927	
M.	R.
Jan. 9, a. m.	
1.33	4.299
1.29	4.314
1.20	4.340
1.17	4.366
1.14	4.407
Jan. 10, a. m.	
2.50	3.632
2.20	3.784
2.00	3.879
1.80	3.970
1.60	4.071
Jan. 12, a. m.	
2.00	4.009
1.80	4.102
1.67	4.155
1.59	4.186
Jan. 13, a. m.	
2.00	4.023
1.80	4.111
1.70	4.160
1.61	4.202
1.50	4.254
Jan. 14, a. m.	
1.43	4.402
1.37	4.411
1.32	4.428
1.28	4.450
1.24	4.470
Jan. 17, a. m.	
2.21	3.656
2.02	3.760
1.79	3.873
1.60	3.981
1.50	4.036
Jan. 18, a. m.	
--------	4.238
Jan. 22, a. m.	
2.02	3.926
1.80	4.047
Jan. 23, a. m.	
2.01	4.077
1.80	4.159
1.70	4.213
1.60	4.253
1.50	4.300
Jan. 25, a. m.	
2.48	3.601
2.20	3.705
2.01	3.806
1.80	3.925
1.61	4.014
Jan. 27, a. m.	
1.03	4.306
1.02	4.323

1927	
M.	R.
Jan. 30, a. m.	
1.61	3.916
1.51	3.954
1.43	3.997
1.37	4.018
1.32	4.066
Feb. 4, a. m.	
2.32	3.784
2.10	3.894
1.90	3.969
1.69	4.074
1.60	4.127
Feb. 6, a. m.	
1.06	4.294
1.05	4.285
1.04	4.306
Feb. 8, a. m.	
2.00	3.913
1.80	3.991
1.60	4.075
1.51	4.130
1.43	4.180
Feb. 9, a. m.	
1.80	4.253
1.70	4.279
1.60	4.304
1.50	4.345
1.43	4.351
Feb. 10, a. m.	
2.80	3.837
2.50	3.945
2.20	4.055
2.00	4.145
1.58	4.319
Feb. 11, a. m.	
1.10	4.570
1.09	4.570
1.07	4.580
1.06	4.603
1.05	4.600
Feb. 12, a. m.	
4.38	3.495
3.56	3.713
3.00	3.863
2.50	4.020
1.80	4.352
1.30	4.580
Feb. 13, a. m.	
1.30	4.537
1.26	4.561
1.22	4.573
1.20	4.609
1.16	4.611

1927	
M.	R.
Feb. 14, a. m.	
2.77	3.979
2.50	4.079
2.20	4.174
2.00	4.256
1.60	4.417
Feb. 15, a. m.	
2.80	3.890
2.50	3.987
2.21	4.085
2.00	4.157
1.60	4.337
Feb. 16, a. m.	
2.80	3.573
2.50	3.701
2.20	3.822
2.00	3.905
1.60	4.095
Feb. 17, a. m.	
1.50	4.069
1.43	4.095
1.37	4.129
Feb. 19, a. m.	
2.80	3.577
2.49	3.691
2.20	3.814
2.00	3.895
1.60	4.101
Feb. 24, a. m.	
1.42	4.023
1.32	4.085
1.24	4.135
1.17	4.188
1.13	4.216
Feb. 28, a. m.	
1.55	4.106
Mar. 1, a. m.	
1.29	4.258
1.17	4.310
1.14	4.323
Mar. 7, a. m.	
2.18	3.668
1.90	3.806
1.66	3.926
1.50	3.981
Mar. 8, a. m.	
1.33	4.183
Mar. 10, a. m.	
1.15	4.127
1.12	4.145

1927	
M.	R.
Mar. 13, a. m.	
2.18	3.767
2.00	3.850
1.80	3.936
1.60	4.024
1.51	4.064
Mar. 14, a. m.	
2.20	3.837
2.00	3.922
1.80	4.013
1.60	4.102
1.50	4.139
Mar. 15, a. m.	
2.78	3.648
2.50	3.762
1.99	3.963
1.80	4.042
1.60	4.127
Mar. 17, a. m.	
1.44	4.255
1.39	4.278
1.34	4.300
Mar. 18, a. m.	
2.46	3.868
Mar. 19, a. m.	
2.00	4.036
1.80	4.121
1.70	4.156
1.60	4.215
1.50	4.232
Mar. 20, a. m.	
2.80	3.725
2.52	3.814
2.19	3.945
2.00	4.009
1.80	4.098
Mar. 21, a. m.	
4.95	3.080
3.99	3.327
2.99	3.631
2.50	3.802
2.00	3.989
1.50	4.218
Mar. 22, a. m.	
2.79	3.715
2.48	3.810
1.60	4.178
1.50	4.205
1.42	4.223
Mar. 23, a. m.	
2.80	3.698
2.50	3.814
2.18	3.913
2.00	3.999
1.60	4.169

1927	
M.	R.
Mar. 24, a. m.	
2.79	3.575
2.50	3.696
2.20	3.837
2.00	3.941
1.59	4.125
Mar. 25, a. m.	
2.21	3.758
2.01	3.829
1.81	3.963
1.60	4.058
1.50	4.111
Mar. 26, a. m.	
2.50	3.694
2.20	3.806
2.00	3.890
1.81	3.977
1.71	4.025
Mar. 27, a. m.	
1.10	4.321
1.10	4.342
1.10	4.315
Mar. 28, a. m.	
2.80	3.669
2.50	3.737
2.19	3.878
2.00	3.956
1.60	4.135
Mar. 29, a. m.	
2.50	3.602
2.20	3.736
2.00	3.821
1.80	3.914
1.60	4.018
Mar. 30, a. m.	
2.51	3.644
2.19	3.754
2.01	3.832
1.79	3.945
1.60	4.023
Mar. 31, a. m.	
1.62	4.275
Apr. 1, a. m.	
1.32	4.541
1.22	4.582
1.18	4.596
1.15	4.599
1.12	4.606
Apr. 2, a. m.	
2.96	3.950
2.50	4.095
2.20	4.189
1.99	4.285
1.50	4.467

1927	
M.	R.
Apr. 3, a. m.	
4.54	3.519
3.82	3.654
3.02	3.895
2.50	4.060
2.00	4.228
1.50	4.446
Apr. 5, a. m.	
2.20	4.180
1.80	4.315
1.60	4.390
1.50	4.424
1.43	4.446
Apr. 9, a. m.	
1.44	4.236
1.39	4.257
1.35	4.288
1.30	4.300
1.27	4.348
Apr. 10, a. m.	
1.70	4.236
1.51	4.328
1.38	4.373
1.30	4.408
1.25	4.431
Apr. 11, a. m.	
1.70	4.207
1.50	4.284
1.44	4.305
1.40	4.320
1.36	4.338
Apr. 12, a. m.	
3.00	3.713
2.50	3.888
2.00	4.070
1.80	4.142
1.50	4.258
Apr. 13, a. m.	
4.90	3.281
3.96	3.513
2.99	3.780
2.50	3.931
1.99	4.142
1.51	4.342
Apr. 14, a. m.	
2.50	3.851
2.20	3.963
2.00	4.041
1.80	4.128
1.50	4.271
Apr. 15, a. m.	
3.01	3.696
2.50	3.895
2.20	4.004
1.99	4.060
1.50	4.279

1927	
M.	R.
Apr. 16, a. m.	
3.00	3.668
2.50	3.851
2.19	3.963
1.99	4.036
1.50	4.222
Apr. 17, a. m.	
3.00	3.465
2.50	3.610
2.20	3.718
1.70	3.915
Apr. 18, a. m.	
3.01	3.481
2.50	3.667
2.21	3.784
2.00	3.890
1.50	4.146
Apr. 19, a. m.	
3.00	3.664
2.50	3.825
2.20	3.941
2.01	4.032
1.50	4.234
Apr. 20, a. m.	
4.92	3.182
4.00	3.432
3.02	3.690
2.50	3.858
2.00	4.073
1.50	4.257
Apr. 21, a. m.	
3.00	3.718
2.50	3.913
2.21	4.004
2.01	4.072
1.50	4.282
Apr. 23, a. m.	
2.13	3.869
2.00	3.927
1.86	3.981
1.70	4.040
1.60	4.079
Apr. 25, a. m.	
1.36	4.418
1.33	4.433
1.30	4.439
1.28	4.430
1.26	4.436
Apr. 26, a. m.	
3.01	3.812
2.50	3.968
2.02	4.145
1.80	4.230
1.50	4.350

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1927	
M.	R.
Apr. 27, a. m.	
5.00	3.273
4.00	3.491
3.02	3.754
2.50	3.931
1.99	4.088
1.50	4.241
Apr. 28, a. m.	
3.00	3.713
2.51	3.895
2.20	4.004
2.00	4.064
1.50	4.259
Apr. 29, a. m.	
3.00	3.728
2.50	3.895
2.21	3.995
2.00	4.069
1.50	4.251
Apr. 30, a. m.	
3.00	3.780
2.50	3.934
2.20	4.046
2.00	4.111
1.50	4.308
May 1, a. m.	
2.99	3.776
2.50	3.931
2.20	4.033
2.00	4.103
1.50	4.271
May 2, a. m.	
3.00	3.664
2.50	3.847
2.20	3.951
2.00	4.023
1.50	4.235
May 3, a. m.	
4.93	3.260
3.98	3.483
3.00	3.754
2.50	3.911
2.00	4.089
1.50	4.276
May 4, a. m.	
2.98	3.750
2.50	3.922
2.20	4.012
2.00	4.084
1.50	4.276
May 5, a. m.	
3.00	3.746
2.50	3.904
1.91	4.126
1.60	4.261
1.50	4.300

1927	
M.	R.
May 7, a. m.	
2.80	3.833
2.50	3.926
2.20	4.027
2.00	4.093
1.50	4.285
May 8, a. m.	
1.37	4.306
May 9, a. m.	
1.42	4.363
1.39	4.411
1.37	4.378
1.35	4.400
1.33	4.394
May 10, a. m.	
4.97	3.346
4.00	3.563
3.00	3.833
2.49	3.990
2.00	4.159
1.50	4.350
May 12, a. m.	
3.00	3.750
2.50	3.908
2.20	4.014
2.00	4.102
1.50	4.303
May 13, a. m.	
3.01	3.777
2.50	3.954
2.20	4.054
2.00	4.122
1.50	4.245
May 14, a. m.	
2.80	3.610
2.50	3.685
2.20	3.797
2.00	3.837
1.60	4.022
May 18, a. m.	
1.80	3.996
1.72	4.018
May 19, a. m.	
3.00	3.815
2.51	3.963
2.20	4.069
2.00	4.150
1.50	4.345
May 20, a. m.	
2.20	4.043
2.00	4.102
1.81	4.163
1.60	4.249
1.50	4.288

1927	
M.	R.
May 21, a. m.	
3.00	3.800
2.49	3.987
2.20	4.074
1.93	4.176
1.50	4.351
May 22, a. m.	
2.80	3.860
2.50	3.945
2.20	4.061
2.00	4.135
1.50	4.335
May 23, a. m.	
3.00	3.827
2.50	3.986
2.20	4.085
2.01	4.150
1.50	4.365
May 24, a. m.	
4.97	3.416
3.98	3.635
3.01	3.882
2.51	4.018
1.99	4.195
May 25, a. m.	
3.00	3.698
2.50	3.842
2.18	3.943
2.00	3.999
1.50	4.198
May 26, a. m.	
2.99	3.635
2.50	3.787
2.19	3.908
1.99	3.999
1.50	4.217
May 27, a. m.	
3.00	3.707
2.50	3.842
2.20	3.962
2.00	4.027
1.50	4.210
May 28, a. m.	
2.98	3.597
2.50	3.750
2.19	3.854
2.00	3.934
1.50	4.141
May 29, a. m.	
3.00	3.658
2.51	3.802
2.21	3.886
2.00	3.981

1927	
M.	R.
May 30, a. m.	
2.50	3.784
2.20	3.890
2.00	3.963
1.80	4.060
1.50	4.191
May 31, a. m.	
3.00	3.602
2.50	3.793
2.20	3.886
2.00	3.954
1.50	4.163
June 1, a. m.	
3.01	3.614
2.50	3.748
2.20	3.855
2.00	3.922
1.50	4.165
June 2, a. m.	
3.00	3.611
2.50	3.780
2.20	3.886
2.00	3.946
1.50	4.143
June 3, a. m.	
3.01	3.698
2.50	3.846
2.20	3.954
2.00	4.018
1.81	4.081
June 4, a. m.	
3.00	3.748
2.50	3.913
2.20	4.014
2.01	4.079
1.80	4.152
June 5, a. m.	
3.00	3.677
2.50	3.840
2.21	3.949
2.00	4.018
1.50	4.215
June 7, a. m.	
3.00	3.769
2.50	3.950
2.23	4.046
2.01	4.121
1.50	4.300
June 8, a. m.	
4.98	3.225
4.00	3.451
2.99	3.721
2.50	3.886
2.00	4.046
1.50	4.247

1927	
M.	R.
June 9, a. m.	
3.00	3.700
2.50	3.869
2.19	3.972
2.00	4.045
1.50	4.226
June 10, a. m.	
3.01	3.760
2.50	3.893
2.20	3.999
2.00	4.093
1.50	4.274
June 11, a. m.	
2.99	3.770
2.49	3.931
2.20	4.030
2.00	4.098
1.50	4.296
June 12, a. m.	
3.00	3.819
2.50	3.941
2.20	4.051
2.00	4.125
1.80	4.207
June 13, a. m.	
3.00	3.798
2.51	3.945
2.20	4.042
1.99	4.116
1.50	4.318
June 14, a. m.	
2.99	3.715
2.50	3.878
2.20	3.959
2.00	4.022
1.50	4.193
June 15, a. m.	
3.00	3.715
2.48	3.864
2.18	3.971
2.00	4.042
1.50	4.251
June 16, a. m.	
3.00	3.589
2.50	3.733
2.20	3.868
2.00	3.963
1.50	4.198
June 22, a. m.	
3.00	3.669
2.50	3.808
2.18	3.926
2.00	3.986

1927	
M.	R.
June 23, a. m.	
3.01	3.711
2.51	3.868
2.20	3.969
2.00	4.030
1.50	4.238
June 24, a. m.	
5.00	3.181
4.03	3.404
3.01	3.654
2.50	3.789
2.00	3.979
1.50	4.190
June 25, a. m.	
2.99	3.763
2.51	3.890
2.20	3.976
2.00	4.054
1.50	4.250
June 26, a. m.	
2.99	3.915
2.50	4.051
2.09	4.169
1.85	4.240
1.70	4.286
June 27, a. m.	
3.01	3.802
2.50	3.974
2.20	4.074
2.00	4.155
1.50	4.318
June 28, a. m.	
5.01	3.323
3.99	3.576
3.00	3.825
2.50	3.960
2.00	4.091
1.50	4.266
June 29, a. m.	
1.58	4.112
1.51	4.154
1.47	4.177
1.45	4.185
June 30, a. m.	
2.96	3.791
2.31	3.971
2.04	4.064
1.85	4.150
1.68	4.223
July 1, a. m.	
2.59	4.014
2.20	4.122
1.93	4.215
1.70	4.291
1.59	4.322

1927	
M.	R.
July 2, a. m.	
3.00	3.869
2.50	4.016
2.20	4.115
1.99	4.187
1.80	4.252
July 5, a. m.	
2.51	3.793
2.20	3.925
2.00	3.982
1.80	4.023
1.61	4.083
July 7, a. m.	
2.00	4.082
1.69	4.189
1.60	4.221
July 8, a. m.	
2.98	3.849
2.50	3.981
2.19	4.067
1.99	4.138
1.80	4.207
July 10, a. m.	
3.02	3.830
2.40	4.009
2.20	4.067
2.00	4.147
1.80	4.216
July 11, a. m.	
4.96	3.365
3.99	3.563
3.00	3.819
2.50	3.986
2.00	4.145
1.50	4.315
July 13, a. m.	
3.01	3.637
2.50	3.810
2.19	3.926
2.00	3.986
1.50	4.173
July 14, a. m.	
3.00	3.733
2.48	3.906
2.20	3.999
2.00	4.064
1.50	4.273
July 15, a. m.	
2.99	3.750
2.50	3.910
2.20	4.019
2.00	4.091
1.50	4.275

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629

1927	
M.	R.
July 16, a. m.	
3.00	3.767
2.51	3.924
2.20	4.031
2.00	4.096
1.50	4.282
July 17, a. m.	
2.99	3.732
2.50	3.894
2.19	4.009
2.00	4.076
1.81	4.145
July 18, a. m.	
5.00	3.264
3.99	3.499
3.00	3.758
2.51	3.923
2.00	4.105
1.50	4.316
July 19, a. m.	
2.99	3.789
2.50	3.908
2.16	4.036
2.00	4.105
1.45	4.317
July 20, a. m.	
3.00	3.804
2.50	3.963
2.19	4.064
2.00	4.128
1.50	4.343
July 21, a. m.	
2.69	3.913
2.43	3.995
2.20	4.069
2.00	4.144
1.50	4.348
July 22, a. m.	
2.79	3.754
2.51	3.837
2.20	3.948
2.00	4.011
1.49	4.243
July 23, a. m.	
3.00	3.864
2.50	3.999
2.20	4.107
2.00	4.178
1.50	4.370
July 24, a. m.	
3.00	3.855
2.50	4.004
2.18	4.105
2.01	4.159
1.81	4.222

1927	
M.	R.
July 25, a. m.	
4.94	3.438
3.90	3.656
3.00	3.877
2.49	4.027
2.00	4.197
1.50	4.405
July 26, a. m.	
3.00	3.948
2.50	4.102
2.20	4.198
1.99	4.266
1.50	4.443
July 27, a. m.	
3.01	3.889
2.50	4.039
2.20	4.132
2.00	4.196
1.50	4.373
July 28, a. m.	
2.80	3.802
2.50	3.890
2.20	3.980
2.00	4.039
1.50	4.239
July 29, a. m.	
3.00	3.678
2.50	3.824
2.20	3.928
1.99	4.032
1.50	4.234
July 30, a. m.	
3.00	3.614
2.50	3.784
2.20	3.890
2.00	3.963
1.50	4.175
July 31, a. m.	
2.97	3.577
2.49	3.735
2.20	3.842
2.01	3.917
1.81	4.009
Aug. 1, a. m.	
4.90	3.142
3.91	3.388
3.01	3.660
2.49	3.826
2.00	3.992
1.50	4.188
Aug. 2, a. m.	
2.99	3.762
2.50	3.910
2.20	4.018
2.00	4.093
1.50	4.278

1927	
M.	R.
Aug. 3, a. m.	
3.00	3.721
2.50	3.901
2.20	3.981
2.00	4.074
1.47	4.311
Aug. 4, a. m.	
3.00	3.807
2.50	3.941
2.20	4.045
2.00	4.123
1.50	4.312
Aug. 5, a. m.	
3.00	3.752
2.49	3.932
2.20	4.041
2.00	4.107
1.40	4.369
Aug. 6, a. m.	
3.00	3.788
2.50	3.935
2.20	4.038
2.00	4.101
1.50	4.299
Aug. 7, a. m.	
3.00	3.771
2.50	3.937
2.20	4.032
2.00	4.116
1.50	4.282
Aug. 8, a. m.	
4.93	3.493
3.97	3.714
3.00	3.950
2.50	4.104
1.99	4.266
1.45	4.446
Aug. 9, a. m.	
3.01	3.893
2.50	4.041
2.19	4.147
1.99	4.221
1.50	4.423
Aug. 10, a. m.	
3.00	3.819
2.51	3.976
2.20	4.079
1.95	4.176
1.50	4.355
Aug. 11, a. m.	
1.70	4.330
1.60	4.365
1.50	4.417
1.46	4.426
1.40	4.439

1927	
M.	R.
Aug. 14, a. m.	
3.01	3.890
2.51	4.051
2.20	4.150
2.00	4.224
1.70	4.323
Aug. 15, a. m.	
3.01	3.934
2.51	4.054
2.20	4.155
2.00	4.239
1.50	4.406
Aug. 16, a. m.	
4.88	3.363
3.94	3.581
3.00	3.833
2.50	3.988
2.00	4.156
1.50	4.324
Aug. 17, a. m.	
3.00	3.802
2.50	3.944
2.21	4.046
2.00	4.123
1.45	4.316
Aug. 18, a. m.	
2.99	3.851
2.50	4.012
2.20	4.121
2.00	4.188
1.50	4.365
Aug. 19, a. m.	
2.99	3.715
2.50	3.879
2.00	4.079
1.80	4.151
1.50	4.276
Aug. 20, a. m.	
2.99	3.807
2.51	3.959
2.20	4.058
2.00	4.133
1.50	4.310
Aug. 21, a. m.	
2.99	3.671
2.47	3.842
2.14	3.955
1.87	4.062
1.69	4.132
Aug. 22, a. m.	
2.99	3.670
2.47	3.870
2.15	3.985
1.90	4.080
1.71	4.158

1927	
M.	R.
Aug. 23, a. m.	
2.93	3.771
2.44	3.932
2.13	4.046
1.90	4.145
1.72	4.224
Aug. 24, a. m.	
2.97	3.688
2.49	3.867
2.15	3.987
1.90	4.079
1.71	4.151
Aug. 25, a. m.	
3.01	3.634
2.50	3.813
2.20	3.926
2.00	3.999
1.50	4.212
Aug. 26, a. m.	
2.80	3.834
2.49	3.934
2.20	4.028
2.00	4.121
1.50	4.345
Aug. 27, a. m.	
3.00	3.800
2.50	3.977
2.20	4.074
2.00	4.159
1.50	4.367
Aug. 28, a. m.	
2.50	4.093
2.20	4.178
2.00	4.266
1.80	4.330
1.50	4.416
Aug. 29, a. m.	
2.97	3.842
2.50	3.966
2.20	4.057
2.00	4.132
1.50	4.320
Aug. 30, a. m.	
4.89	3.192
3.97	3.400
3.01	3.673
2.50	3.842
2.00	4.009
1.50	4.184
Aug. 31, a. m.	
2.80	3.770
2.50	3.861
2.20	3.963
2.00	4.032
1.50	4.208

1927	
M.	R.
Sept. 1, a. m.	
3.00	3.701
1.90	4.079
1.80	4.125
1.61	4.214
1.38	4.287
Sept. 2, a. m.	
3.00	3.737
2.50	3.889
2.21	3.986
2.00	4.060
1.50	4.292
Sept. 3, a. m.	
3.00	3.784
2.42	3.947
2.01	4.093
1.71	4.201
1.56	4.258
Sept. 4, a. m.	
2.99	3.835
2.49	3.974
2.20	4.057
2.00	4.135
1.50	4.340
Sept. 5, a. m.	
3.02	3.897
2.50	4.041
2.20	4.147
2.00	4.205
1.50	4.397
Sept. 6, a. m.	
2.50	3.882
2.19	4.010
2.00	4.067
1.79	4.145
1.50	4.260
Sept. 9, a. m.	
1.98	4.263
1.79	4.341
1.60	4.421
1.50	4.457
1.44	4.486
Sept. 10, a. m.	
1.80	4.331
1.70	4.375
1.60	4.414
1.50	4.466
1.43	4.495
Sept. 11, a. m.	
2.00	4.200
1.70	4.316
1.44	4.434

927	
M.	R.
Sept. 12, a. m.	
4.86	3.331
3.98	3.548
3.00	3.815
2.50	3.981
2.00	4.158
1.50	4.351
Sept. 13, a. m.	
3.00	3.843
2.49	3.981
2.20	4.065
2.00	4.155
1.50	4.380
Sept. 14, a. m.	
3.00	3.855
2.51	4.015
2.20	4.121
1.90	4.230
1.50	4.401
Sept. 15, a. m.	
2.50	4.038
2.20	4.149
2.00	4.222
1.80	4.285
1.50	4.406
Sept. 16, a. m.	
3.01	3.864
2.50	4.018
2.00	4.207
1.79	4.290
1.51	4.409
Sept. 17, a. m.	
3.01	3.931
2.50	4.076
2.19	4.169
2.00	4.252
1.50	4.431
Sept. 18, a. m.	
2.96	3.930
2.50	4.074
2.21	4.167
2.00	4.249
1.50	4.446
Sept. 19, a. m.	
3.00	3.901
2.50	4.049
2.20	4.160
1.99	4.236
1.50	4.410
Sept. 20, a. m.	
4.95	3.406
3.98	3.631
3.00	3.890
2.50	4.062
2.00	4.236
1.50	4.422

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TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1927	
M.	R.
Sept. 21, a. m.	
2.99	3.814
2.50	3.972
2.00	4.164
1.80	4.244
1.50	4.346
Sept. 22, a. m.	
2.98	3.838
2.49	3.977
2.21	4.081
2.01	4.167
1.50	4.370
Sept. 23, a. m.	
3.00	3.787
2.50	3.935
2.20	4.038
2.01	4.111
1.50	4.324
Sept. 24, a. m.	
3.00	3.800
2.51	3.963
2.21	4.093
2.00	4.167
1.50	4.377
Sept. 28, a. m.	
2.50	4.004
2.21	4.103
2.00	4.159
1.80	4.237
1.50	4.339
Sept. 29, a. m.	
3.00	3.758
2.50	3.945
2.20	4.019
2.00	4.107
Sept. 30, a. m.	
2.78	4.016
2.50	4.111
2.20	4.214
2.01	4.285
1.50	4.487
Oct. 1, a. m.	
2.95	4.020
2.50	4.153
2.20	4.261
1.90	4.360
1.50	4.498
Oct. 3, a. m.	
3.00	3.929
2.50	4.109
2.00	4.285
1.80	4.365
1.50	4.480

1927	
M.	R.
Oct. 4, a. m.	
4.83	3.296
3.90	3.554
3.00	3.819
2.50	3.972
2.00	4.167
1.50	4.404
Oct. 5, a. m.	
2.80	3.913
2.51	3.999
2.19	4.118
2.00	4.188
1.51	4.400
Oct. 6, a. m.	
3.00	3.807
2.50	3.995
2.20	4.108
1.99	4.188
1.50	4.388
Oct. 7, a. m.	
3.00	3.865
2.50	4.020
2.20	4.121
2.00	4.197
1.50	4.391
Oct. 9, a. m.	
1.43	4.188
1.38	4.227
1.32	4.267
Oct. 10, a. m.	
3.00	3.864
2.50	4.026
2.20	4.120
2.01	4.205
1.50	4.379
Oct. 11, a. m.	
2.98	3.681
2.49	3.848
2.20	3.948
2.00	4.047
1.50	4.271
Oct. 12, a. m.	
4.94	3.268
3.96	3.497
3.02	3.802
2.50	3.972
2.00	4.156
1.50	4.371
Oct. 13, a. m.	
3.00	3.735
2.50	3.893
2.21	4.004
2.01	4.095
1.50	4.325

1927	
M.	R.
Oct. 14, a. m.	
2.98	3.546
2.49	3.728
2.20	3.852
2.00	3.950
1.50	4.158
Oct. 15, a. m.	
2.91	3.577
2.50	3.707
2.21	3.784
2.01	3.908
1.50	4.234
Oct. 16, a. m.	
2.00	4.140
1.80	4.215
1.70	4.267
1.60	4.300
1.50	4.350
Oct. 19, a. m.	
1.05	4.560
Oct. 20, a. m.	
3.00	3.617
2.50	3.798
2.21	3.917
2.00	3.996
1.50	4.252
Oct. 21, a. m.	
3.00	3.796
2.50	3.956
2.21	4.060
2.00	4.140
1.50	4.345
Oct. 22, a. m.	
4.93	3.327
3.96	3.528
3.01	3.831
2.50	4.002
2.00	4.188
1.50	4.413
Oct. 23, a. m.	
1.11	4.611
1.09	4.599
1.06	4.632
Oct. 25, a. m.	
2.99	3.873
2.50	4.045
2.21	4.150
1.79	4.302
1.50	4.409
Oct. 26, a. m.	
3.01	3.818
2.51	3.972
2.20	4.074
1.99	4.185
1.49	4.385

1927	
M.	R.
Oct. 27, a. m.	
2.99	3.581
2.50	3.767
2.20	3.886
2.00	3.936
1.50	4.179
Oct. 28, a. m.	
1.14	4.425
Oct. 29, a. m.	
2.51	3.824
2.21	3.951
2.01	4.043
1.80	4.119
1.50	4.263
Oct. 30, a. m.	
2.98	3.646
2.49	3.842
2.20	3.963
2.00	4.036
1.50	4.285
Oct. 31, a. m.	
3.00	3.819
2.50	3.986
2.20	4.091
1.95	4.173
Nov. 1, a. m.	
3.02	3.629
2.50	3.832
Nov. 2, a. m.	
1.55	4.508
1.42	4.570
1.35	4.613
1.31	4.646
1.25	4.682
Nov. 3, a. m.	
4.97	3.356
4.00	3.595
3.00	3.902
2.50	4.058
2.00	4.238
1.50	4.456
Nov. 4, a. m.	
3.02	3.781
2.50	3.954
2.20	4.067
2.00	4.140
1.50	4.396
Nov. 5, a. m.	
2.98	3.886
2.50	4.029
2.10	4.188

1927	
M.	R.
Nov. 7, a. m.	
1.81	4.266
1.70	4.311
1.60	4.367
1.50	4.406
1.40	4.469
Nov. 8, a. m.	
3.02	3.818
2.50	4.004
2.22	4.110
2.00	4.217
1.50	4.462
Nov. 9, a. m.	
3.00	3.977
2.51	4.142
2.20	4.249
2.00	4.338
1.50	4.556
Nov. 10, a. m.	
4.90	3.405
3.91	3.680
3.00	3.945
2.49	4.120
2.00	4.297
1.50	4.532
Nov. 11, a. m.	
2.41	4.051
2.00	4.206
1.70	4.345
1.60	4.380
1.50	4.431
Nov 12, a. m.	
3.00	3.945
2.50	4.111
2.19	4.218
2.00	4.310
1.50	4.523
Nov. 13, a. m.	
2.81	--------
2.50	4.050
2.21	4.144
2.01	4.207
1.50	4.426
Nov. 15, a. m.	
2.51	3.850
2.20	3.988
2.00	4.042
1.60	4.251
1.50	4.282
Nov. 17, a. m.	
1.66	4.271
1.57	4.305
1.37	4.381
Nov. 18, a. m.	
1.90	3.988
1.64	4.098

1927	
M.	R.
Nov. 19, a. m.	
3.00	3.626
2.50	3.797
2.20	3.899
2.00	4.002
1.50	4.248
Nov. 22, a. m.	
2.50	3.950
2.21	4.054
2.00	4.159
1.60	4.330
1.50	4.385
Nov. 23, a. m.	
5.00	2.992
3.97	3.319
3.02	3.644
2.49	3.844
2.00	4.096
1.50	4.371
Nov. 24, a. m.	
3.00	3.830
2.50	3.980
2.20	4.095
2.01	4.174
1.50	4.415
Nov. 25, a. m.	
3.01	3.839
2.52	4.014
2.20	4.130
2.01	4.203
1.50	4.431
Nov. 29, a. m.	
1.43	4.333
1.36	4.360
1.30	4.390
1.26	4.405
Nov. 30, a. m.	
3.00	3.945
2.52	4.091
2.20	4.201
2.00	4.277
1.50	4.502
Dec. 1, a. m.	
3.00	3.950
2.50	4.132
2.20	4.224
2.00	4.304
1.50	4.508
Dec. 2, a. m.	
5.05	3.402
4.02	3.664
3.00	3.959
2.50	4.105
2.00	4.281
1.50	4.488

1927	
M.	R.
Dec. 3, a. m.	
3.00	3.921
2.50	4.084
2.20	4.188
2.00	4.260
1.50	4.470
Dec. 6, a. m.	
1.60	4.189
1.50	4.226
1.40	4.272
1.34	4.305
1.30	4.319
Dec. 7, a. m.	
3.02	3.828
2.48	4.016
2.20	4.120
2.00	4.207
1.50	4.419
Dec. 8, a. m.	
2.80	3.895
2.51	3.990
2.21	4.093
2.00	4.167
1.50	4.411
Dec. 9, a. m.	
2.98	3.718
2.50	3.877
2.19	4.018
2.00	4.111
1.50	4.355
Dec. 10, a. m.	
4.95	3.114
3.97	3.362
3.00	3.664
2.50	3.875
2.00	4.086
1.50	4.347
Dec. 11, a. m.	
2.81	3.837
2.51	3.953
2.20	4.070
2.00	4.150
1.50	4.373
Dec. 12, a. m.	
3.00	3.819
2.49	4.004
2.19	4.121
2.00	4.193
1.49	4.429
Dec. 14, a. m.	
2.50	3.973
2.20	4.018
2.01	4.066
1.70	4.210

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1927	
M.	R.
Dec. 15, a. m.	
1.99	4.089
1.80	4.159
1.59	4.274
1.50	4.325
1.40	4.376
Dec. 16, a. m.	
1.30	4.231
1.22	4.285
1.18	4.300
Dec. 18, a. m.	
1.13	4.332
1.08	4.349
Dec. 22, a. m.	
2.50	3.867
2.19	3.995
2.00	4.074
1.70	4.212
1.60	4.257
Dec. 24, a. m.	
1.15	4.435
Dec. 25, a. m.	
2.98	3.745
2.50	3.923
2.21	4.036
2.00	4.116
1.50	4.350
Dec. 26, a. m.	
3.00	3.685
2.50	3.878
2.20	3.995
2.00	4.072
1.50	4.340
Dec. 27, a. m.	
2.20	3.821
2.00	3.906
1.70	4.055
1.60	4.119
1.50	4.193
Dec. 28, a. m.	
2.20	4.020
2.00	4.098
1.70	4.213
1.59	4.261
1.50	4.300
Dec. 30, a. m.	
1.50	4.389
1.40	4.424
1.34	4.446
1.30	4.459
1.25	4.477

1928	
M.	R.
Jan. 2, a. m.	
2.61	3.964
1.92	4.230
Jan. 3, a. m.	
4.86	3.390
3.94	3.618
3.01	3.890
2.50	4.064
2.00	4.264
1.50	4.462
Jan. 4, a. m.	
3.00	3.729
2.17	4.042
2.00	4.113
1.59	4.305
1.50	4.346
Jan. 5, a. m.	
3.02	3.694
2.51	3.861
2.20	3.999
1.99	4.088
1.50	4.314
Jan. 6, a. m.	
3.00	3.622
2.50	3.800
2.19	3.914
2.00	4.014
1.50	4.251
Jan. 8, a. m.	
3.00	3.608
2.51	3.820
2.21	3.931
2.00	4.027
1.81	4.123
Jan. 9, a. m.	
2.50	3.724
2.20	3.862
2.00	3.958
1.60	4.118
1.50	4.159
Jan. 10, a. m.	
2.95	3.536
2.49	3.711
2.00	3.921
1.80	4.029
1.50	4.155
Jan. 11, a. m.	
2.99	3.422
2.50	3.605
2.20	3.763
2.00	3.856
1.80	3.946

1928	
M.	R.
Jan. 13, a. m.	
1.30	4.343
1.25	4.350
1.21	4.374
1.17	4.397
Jan. 14, a. m.	
2.50	3.589
2.19	3.715
2.00	3.799
1.80	3.906
1.60	4.048
Jan. 15, a. m.	
1.40	4.144
1.34	4.181
1.30	4.201
1.25	4.233
Jan. 16, a. m.	
1.89	3.927
1.70	4.010
1.49	4.120
1.40	4.169
1.30	4.234
Jan. 17, a. m.	
1.30	4.169
1.20	4.236
Jan. 18, a. m.	
1.15	4.244
1.13	4.233
Jan. 24, a. m.	
2.21	3.802
1.90	3.952
1.63	4.090
1.48	4.174
Jan. 25, a. m.	
1.52	4.139
1.42	4.188
1.32	4.250
Jan. 27, a. m.	
4.84	2.721
3.93	3.006
2.98	3.340
2.50	3.518
2.00	3.739
1.50	4.038
Jan. 28, a. m.	
3.00	3.447
2.49	3.663
2.20	3.787
1.60	4.085
1.50	4.139

1928	
M.	R.
Jan. 29, a. m.	
2.80	3.644
2.30	3.860
2.00	3.981
1.79	4.100
1.50	4.247
Jan. 30, a. m.	
2.90	3.616
2.48	3.780
2.00	4.074
1.50	4.246
1.40	4.281
Jan. 31, a. m.	
3.00	3.576
2.49	3.805
2.20	3.938
1.90	4.069
1.71	4.172
Feb. 1, a. m.	
2.50	3.872
2.19	4.000
2.00	4.083
1.80	4.207
1.60	4.334
Feb. 2, a. m.	
3.00	3.830
2.50	3.981
2.20	4.093
2.00	4.193
1.50	4.402
Feb. 3, a. m.	
2.89	3.612
2.50	3.794
2.19	3.899
1.90	4.027
1.50	4.274
Feb. 5, a. m.	
1.32	4.364
1.24	4.389
1.19	4.421
1.16	4.443
Feb. 6, a. m.	
3.00	3.654
2.48	3.850
2.18	3.963
2.00	4.035
1.50	4.266
Feb. 7, a. m.	
4.55	3.335
3.67	3.588
2.98	3.800
2.49	3.954
2.00	4.161
1.50	4.385

1928	
M.	R.
Feb. 8, a. m.	
3.00	3.692
2.50	3.890
2.19	4.023
2.00	4.100
1.50	4.361
Feb. 9, a. m.	
3.00	3.682
2.51	3.860
2.20	3.978
2.00	4.074
1.50	4.324
Feb. 10, p. m.	
1.02	4.633
1.01	4.609
1.01	4.661
Feb. 11, a. m.	
3.00	3.861
2.00	4.236
1.80	4.335
1.60	4.414
1.50	4.462
Feb. 12, a. m.	
3.01	3.864
2.49	4.045
2.20	4.142
2.00	4.232
1.50	4.456
Feb. 13, a. m.	
3.00	3.861
2.50	4.023
2.20	4.121
2.00	4.214
1.50	4.434
Feb. 14, a. m.	
2.97	3.829
2.50	4.002
2.19	4.121
2.00	4.193
1.50	4.393
Feb. 16, a. m.	
2.08	4.289
1.50	4.508
1.40	4.556
1.34	4.581
1.29	4.592
Feb. 17, a. m.	
2.20	4.108
2.00	4.182
1.80	4.262
1.60	4.356
1.50	4.399

1928	
M.	R.
Feb. 18, a. m.	
2.99	3.698
2.50	3.890
2.20	3.991
2.00	4.081
1.70	4.220
Feb. 21, a. m.	
1.60	4.136
1.50	4.179
1.40	4.245
1.33	4.285
1.27	4.318
Feb. 25, a. m.	
1.15	4.222
Feb. 27, a. m.	
1.45	4.148
1.29	4.236
1.20	4.318
Feb. 29, a. m.	
1.18	4.418
1.14	4.426
1.12	4.436
1.10	4.440
1.06	4.479
Mar. 2, a. m.	
1.23	4.439
1.16	4.402
1.12	4.430
1.10	4.446
1.08	4.436
Mar. 3, a. m.	
1.50	4.262
1.42	4.292
Mar. 4, a. m.	
2.77	3.795
2.49	3.909
2.20	4.033
2.00	4.119
1.80	4.207
Mar. 5, a. m.	
1.17	4.426
1.15	4.456
1.10	4.464
1.09	4.488
1.08	4.510
Mar. 6, a. m.	
1.56	4.182
1.48	4.198
Mar. 7, a. m.	
3.00	3.694
2.50	3.874
2.20	3.987
2.00	4.061
1.81	4.148

1928	
M.	R.
Mar. 8, a. m.	
2.10	4.029
1.89	4.130
1.70	4.222
1.60	4.283
1.48	4.349
Mar. 9, a. m.	
4.60	3.327
3.80	3.565
3.01	3.855
2.49	4.018
2.00	4.169
1.50	4.396
Mar. 10, a. m.	
3.00	3.787
2.50	3.966
2.20	4.060
2.00	4.150
1.50	4.363
Mar. 11, a. m.	
3.00	3.789
2.50	3.991
2.20	4.119
2.01	4.188
1.81	4.262
Mar. 12, a. m.	
2.98	3.920
2.49	4.102
2.20	4.196
2.00	4.256
1.50	4.463
Mar. 15, a. m.	
3.00	3.544
2.50	3.753
2.20	3.862
2.00	3.947
1.50	4.197
Mar. 16, a. m.	
1.17	4.226
1.15	4.259
Mar. 17, a. m.	
3.00	3.459
2.20	3.775
2.00	3.860
1.80	3.943
1.50	4.082
Mar. 18, a. m.	
3.01	3.587
2.49	3.741
2.20	3.878
2.00	3.962
1.50	4.175

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1928 M.	R.
Mar. 19, a. m.	
2.97	3.581
2.50	3.770
2.21	3.891
2.00	3.982
1.50	4.243
Mar. 20, a. m.	
4.97	2.994
4.00	3.274
3.00	3.618
2.50	3.795
2.00	4.014
1.50	4.246
Mar. 21, a. m.	
2.80	3.747
2.49	3.878
2.20	3.992
2.00	4.080
1.50	4.333
Mar. 22, a. m.	
3.00	3.703
2.50	3.855
2.19	3.993
2.01	4.074
1.50	4.320
Mar. 23, a. m.	
1.31	4.388
1.27	4.376
1.21	4.417
Mar. 25, a. m.	
1.33	4.292
Mar. 26, a. m.	
2.91	3.522
2.49	3.673
2.20	3.811
2.00	3.885
1.50	4.073
Mar. 27, a. m.	
2.90	3.755
2.50	3.888
2.20	3.990
2.00	4.060
1.80	4.176
Mar. 28, a. m.	
1.33	4.383
Mar. 29, a. m.	
1.67	4.148
1.50	4.207
1.38	4.266
1.30	4.315
1.25	4.328

1928 M.	R.
Mar. 30, a. m.	
1.25	4.322
1.20	4.370
1.16	4.325
Mar. 31, a. m.	
1.55	4.242
1.42	4.283
1.34	4.305
1.25	4.332
1.20	4.347
Apr. 1, a. m.	
1.65	4.209
1.49	4.283
1.32	4.346
Apr. 2, a. m.	
2.48	3.875
1.63	4.205
1.50	4.250
Apr. 3, a. m.	
2.30	3.846
2.00	3.980
1.58	4.169
1.29	4.326
1.24	4.365
Apr. 4, a. m.	
1.24	4.405
1.15	4.452
1.15	4.452
Apr. 5, a. m.	
2.97	3.790
2.45	3.967
2.00	4.129
1.77	4.225
1.50	4.341
Apr. 6, a. m.	
3.05	3.766
2.49	3.950
2.21	4.055
2.00	4.134
1.50	4.329
Apr. 7, a. m.	
3.01	3.751
2.50	3.943
2.20	4.056
2.00	4.185
1.50	4.384
Apr. 8, a. m.	
2.00	4.199
1.80	4.271
1.60	4.350
1.50	4.405
1.43	4.446

1928 M.	R.
Apr. 9, a. m.	
4.99	3.361
3.91	3.619
3.01	3.862
2.50	4.013
2.00	4.207
1.50	4.360
Apr. 10, a. m.	
3.00	3.756
2.51	3.905
2.19	4.003
2.01	4.074
1.50	4.286
Apr. 11, a. m.	
3.00	3.717
2.50	3.892
2.20	4.001
2.00	4.076
1.80	4.154
Apr. 12, a. m.	
2.51	4.009
2.20	4.126
2.00	4.203
1.80	4.283
1.50	4.392
Apr. 13, a. m.	
2.98	3.866
2.50	4.021
2.20	4.110
2.00	4.193
1.50	4.414
Apr. 14, a. m.	
1.18	4.419
1.18	4.402
Apr. 15, a. m.	
2.52	3.835
2.20	3.952
2.00	4.034
1.81	4.110
1.50	4.239
Apr. 16, a. m.	
2.50	3.817
2.20	3.952
2.00	4.018
1.80	4.140
1.70	4.166
Apr. 17, a. m.	
1.25	4.452
1.23	4.440
1.22	4.452
1.20	4.459
1.20	4.480

1928 M.	R.
Apr. 19, a. m.	
3.01	3.647
1.91	4.051
1.45	4.209
1.35	4.247
1.32	4.261
Apr. 20, a. m.	
3.00	3.714
2.51	3.873
2.18	3.972
2.00	4.046
1.50	4.244
Apr. 24, a. m.	
3.01	3.654
2.50	3.843
2.20	3.945
2.00	4.020
1.50	4.230
Apr. 25, a. m.	
2.47	3.667
1.86	3.907
1.65	4.011
1.40	4.097
1.35	4.091
Apr. 26, a. m.	
2.50	3.771
2.20	3.874
2.00	3.962
1.80	4.039
1.50	4.182
Apr. 27, a. m.	
3.01	3.619
2.51	3.783
2.20	3.887
2.01	3.964
1.50	4.185
Apr. 28, a. m.	
4.87	3.193
4.01	3.404
3.00	3.667
2.52	3.848
2.00	4.052
1.50	4.251
Apr. 29, a. m.	
2.99	3.802
2.51	3.942
2.20	4.046
2.00	4.125
1.50	4.324
Apr. 30, a. m.	
2.71	3.783
2.49	3.857
2.21	3.961
2.01	4.030
1.50	4.232

1928 M.	R.
May 1, a. m.	
3.00	3.668
2.64	3.782
2.40	3.870
May 2, a. m.	
2.21	3.997
2.00	4.062
1.79	4.140
1.55	4.250
1.50	4.281
May 3, a. m.	
1.76	4.353
1.59	4.414
1.49	4.420
1.44	4.448
1.40	4.472
May 4, a. m.	
2.00	4.176
1.80	4.246
1.70	4.278
1.50	4.344
1.40	4.380
May 5, a. m.	
3.01	3.859
2.50	4.022
2.18	4.128
1.99	4.190
1.50	4.362
May 6, a. m.	
3.00	3.754
2.54	3.928
2.20	4.016
2.00	4.108
1.50	4.288
May 7, a. m.	
3.00	3.749
2.50	3.882
2.19	3.995
2.00	4.063
1.50	4.256
May 8, a. m.	
3.00	3.734
2.50	3.892
2.20	3.997
2.00	4.074
1.50	4.292
May 9, a. m.	
2.50	3.820
2.20	3.912
2.00	4.016
1.80	4.079
1.50	4.211

1928 M.	R.
May 10, a. m.	
3.00	3.841
2.50	3.997
2.20	4.088
2.00	4.150
1.80	4.212
May 11, a. m.	
4.95	3.375
3.88	3.614
3.02	3.835
2.51	3.998
1.98	4.178
1.50	4.347
May 12, a. m.	
3.00	3.830
2.50	4.036
2.20	4.129
2.00	4.187
1.50	4.381
May 13, a. m.	
3.02	3.735
2.50	3.893
2.22	3.999
2.00	4.077
1.50	4.266
May 14, a. m.	
2.98	3.653
2.51	3.828
2.21	3.927
2.01	4.004
1.50	4.150
May 16, a. m.	
3.00	3.638
2.50	3.790
2.20	3.895
1.99	3.994
1.80	4.057
May 17, a. m.	
1.83	4.108
1.67	4.207
May 18, a. m.	
2.99	3.756
2.54	3.882
2.20	3.980
2.00	4.055
1.50	4.225
May 19, a. m.	
3.00	3.679
2.50	3.823
2.20	3.932
1.80	4.069
1.50	4.190

1928 M.	R.
May 20, a. m.	
3.01	3.664
2.50	3.839
2.20	3.949
2.00	4.007
1.50	4.227
May 21, a. m.	
3.00	3.586
2.47	3.781
2.19	3.874
2.00	3.940
1.50	4.091
May 22, a. m.	
4.94	3.076
4.02	3.289
3.00	3.582
2.49	3.750
2.00	3.917
1.50	4.102
May 23, a. m.	
3.00	3.755
2.50	3.901
2.19	4.000
2.00	4.069
1.50	4.288
May 24, a. m.	
3.02	3.726
2.50	3.878
2.20	3.981
1.99	4.056
1.50	4.253
May 25, a. m.	
1.63	4.200
1.58	4.232
1.55	4.251
1.53	4.285
May 26, a. m.	
3.00	3.869
2.48	4.023
2.19	4.116
2.00	4.188
1.50	4.382
May 27, a. m.	
3.02	3.732
2.50	3.906
2.18	3.997
2.00	4.083
1.80	4.183
May 28, a. m.	
2.99	3.704
2.49	3.872
2.19	3.977
2.00	4.059
1.50	4.224

Table 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1928

M.	R.
May 29, a. m.	
3.00	3.645
2.50	3.818
2.19	3.914
1.99	3.977
1.50	4.180
May 30, a. m.	
5.02	3.111
4.00	3.326
3.01	3.597
2.49	3.779
2.00	3.942
June 1, a. m.	
1.45	4.152
1.43	4.142
1.42	4.161
June 2, a. m.	
2.99	3.647
2.50	3.804
2.19	3.911
2.00	3.985
1.50	4.184
June 3, a. m.	
1.80	4.124
1.72	4.150
1.60	4.195
1.55	4.206
1.50	4.227
June 4, a. m.	
3.01	3.777
2.50	3.942
2.19	4.032
2.00	4.089
1.50	4.293
June 5, a. m.	
2.99	3.817
2.50	3.956
2.20	4.053
2.00	4.131
1.50	4.333
June 6, a. m.	
3.00	3.863
2.50	4.011
2.20	4.111
2.01	4.174
1.80	4.230
June 7, a. m.	
2.95	3.807
2.50	3.956
2.19	4.054
2.00	4.117
1.50	4.289
June 8, a. m.	
3.00	3.863
2.48	4.011
2.20	4.119
2.00	4.189
1.50	4.343
June 9, a. m.	
4.99	3.308
3.97	3.518
3.00	3.776
2.49	3.930
2.00	4.100
1.50	4.275
June 10, a. m.	
3.00	3.731
2.50	3.896
2.20	3.998
2.00	4.060
1.70	4.162
June 11, a. m.	
3.01	3.717
2.50	3.871
2.20	3.976
2.00	4.023
1.50	4.222
June 12, a. m.	
2.99	3.550
2.49	3.722
2.20	3.837
2.01	3.914
1.50	4.134
June 13, a. m.	
2.00	3.917
1.80	4.015
1.70	4.051
1.60	4.095
1.50	4.145
June 16, a. m.	
1.49	4.113
June 17, a. m	
2.37	3.796
2.10	3.906
1.92	3.968
1.70	4.048
1.60	4.090
June 18, a. m.	
2.99	3.976
2.49	4.125
2.21	4.211
2.00	4.285
1.81	4.345
June 19, a. m.	
3.00	3.898
2.50	4.051
2.20	4.147
2.00	4.209
1.50	4.377
June 21, a. m.	
1.45	4.217
1.44	4.236
1.44	4.250
June 22, a. m.	
2.50	3.852
2.20	3.945
2.00	4.016
1.80	4.085
1.66	4.130
June 23, a. m.	
2.97	3.694
2.48	3.855
2.20	3.948
1.98	4.024
1.79	4.094
June 25, a. m.	
1.48	4.203
1.46	4.207
1.45	4.244
June 27, a. m.	
2.99	3.711
2.67	3.795
2.49	3.862
2.00	4.036
1.80	4.151
June 28, a. m.	
1.90	4.129
1.79	4.170
1.58	4.248
1.54	4.269
1.50	4.292
June 29, a. m.	
1.48	4.260
June 30, a. m.	
1.47	4.263
1.44	4.316
July 1, a. m.	
3.00	3.762
2.50	3.915
2.20	4.011
2.00	4.077
1.70	4.201
July 2, a. m.	
3.01	3.835
2.50	3.983
2.19	4.080
1.97	4.150
1.50	4.301
July 3, a. m.	
4.99	3.355
4.01	3.556
2.97	3.833
2.49	3.995
2.01	4.148
1.50	4.332
July 4, a. m.	
2.50	3.932
2.20	4.038
2.00	4.111
1.80	4.184
1.70	4.231
July 5, a. m.	
30.1	3.753
2.50	3.904
2.19	3.995
2.00	4.074
1.50	4.240
July 6, a. m.	
2.99	3.764
2.49	3.926
2.20	3.997
2.00	4.087
1.50	4.281
July 7, a. m.	
3.01	3.815
2.50	3.944
2.20	4.053
1.99	4.130
1.50	4.319
July 8, a. m.	
3.01	3.815
2.50	3.935
2.20	4.037
2.00	4.088
1.50	4.274
July 9, a. m.	
3.00	3.820
2.51	3.952
2.20	4.050
2.00	4.112
1.50	4.312
July 10, a. m.	
2.97	3.635
2.49	3.782
2.21	3.870
2.00	3.936
1.70	4.035
July 11, a. m.	
3.01	3.563
2.49	3.730
2.19	3.878
2.00	3.971
1.50	4.175
July 12, a. m.	
2.50	3.700
2.21	3.773
2.00	3.832
1.90	3.858
1.80	3.912
July 14, a. m.	
2.50	3.948
2.00	4.102
1.79	4.171
1 60	4.231
1.50	4.291
July 15, a. m.	
4.93	3.253
3.96	3.516
3.01	3.818
2.48	3.999
2.00	4.183
1.50	4.381
July 16, a. m.	
2.98	3.856
2.50	3.995
2.19	4.081
2.00	4.138
1.50	4.305
July 17, a. m.	
2.99	3.501
2.49	3.671
2.12	3.803
1.99	3.855
1.80	3.926
July 18, a. m.	
2.20	3.711
2.00	3.797
1.90	3.837
1.79	3.884
1.70	3.924
July 19, a. m.	
2.99	3.697
2.49	3.837
2.20	3.959
2.00	4.032
1.50	4.265
July 20, a. m.	
2.99	3.787
2.49	3.927
2.20	4.021
1.99	4.102
1.50	4.295
July 21, a. m.	
3.00	3.824
2.50	3.968
2.20	4.063
2.00	4.145
1.50	4.344
July 22, a. m.	
1.55	4.260
July 23, a. m.	
1.41	4.327
1.38	4.310
July 24, a. m.	
1.59	4.085
1.54	4.109
1.50	4.123
1.42	4.161
1.40	4.169
July 25, a. m.	
4.97	3.219
4.02	3.455
3.00	3.741
2.48	3.908
1.99	4.090
1.50	4.263
July 26, a. m.	
1.80	4.251
1.70	4.303
1.59	4 343
1.54	4.353
1.50	4.367
July 28, a. m.	
2.00	4.108
1.80	4.172
1.70	4.208
1.59	4.246
1.50	4.277
July 29, a. m.	
1.60	4.222
1.54	4.246
1.50	4.266
1.45	4.287
1.41	4.305
July 30, a. m.	
3.01	3.817
2.50	3.955
2.19	4.046
2.00	4.117
1.70	4.227
July 31, a. m.	
3.04	3.817
Aug. 1, a. m.	
1.60	4.048
1.50	4.095
Aug. 4, a. m.	
1.51	4.128
1.32	4.188
1.31	4.189
1.30	4.190
Aug. 5, a. m.	
3.00	3.631
2.49	3.779
2.19	3.890
2.00	3.960
1.69	4.065
Aug. 6, a. m.	
4.89	3.279
4.02	3.483
2.99	3.750
2.48	3.920
1.99	4.093
1.50	4.270
Aug. 7, a. m.	
3.00	3.769
2.49	3.944
2.20	4.039
2.00	4.112
1.49	4.305
Aug. 10, a. m.	
1.59	4.044
1.53	4.072
1.48	4.089
1.42	4.121
1.38	4.130
Aug. 12, a. m.	
1.70	4.048
1.54	4.093
1.48	4.106
1.40	4.207
1.36	4.248
Aug. 13, a. m.	
2.99	3.790
2.50	3.968
2.20	4.078
2.00	4.152
1.50	4.320
Aug. 14, a. m.	
4.84	3.504
3.90	3.693
3.00	3.943
2.48	4.092
1.99	4.238
1.50	4.410

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1928	
M.	R.
Aug. 15, a. m.	
2.14	4.140
1.75	4.241
1.68	4.252
Aug. 16, a. m.	
3.00	3.891
2.50	4.055
2.19	4.137
1.80	4.244
1.50	4.325
Aug. 17, a. m.	
2.50	3.980
2.20	4.059
1.99	4.130
1.80	4.213
1.50	4.344
Aug. 18, a. m.	
2.99	3.851
2.49	4.018
2.20	4.117
2.00	4.190
1.50	4.373
Aug. 19, a. m.	
2.98	3.735
2.49	3.906
2.20	4.003
1.99	4.073
1.50	4.235
Aug. 20, a. m.	
4.99	3.177
3.97	3.448
3.00	3.731
2.49	3.891
2.00	4.053
1.50	4.240
Aug. 21, a. m.	
2.97	3.765
2.50	3.908
2.20	4.004
2.00	4.051
1.49	4.246
Aug. 22, a. m.	
3.00	3.545
2.50	3.726
2.20	3.841
2.00	3.928
1.70	4.073
Aug. 23, a. m.	
2.99	3.536
2.51	3.750
2.18	3.906
2.00	3.995
1.50	4.249

1928	
M.	R.
Aug. 24, a. m.	
2.98	3.563
2.50	3.750
2.20	3.875
2.00	3.972
1.50	4.217
Aug. 25, a. m.	
3.01	3.655
2.50	3.823
2.19	3.951
2.00	4.036
1.50	4.259
Aug. 26, a. m.	
3.00	3.646
2.49	3.835
2.21	3.943
2.00	4.020
1.50	4.229
Aug. 31, a. m.	
2.49	3.947
2.19	4.073
2.00	4.150
1.80	4.215
1.50	4.326
Sept. 1, a. m.	
3.01	3.802
2.49	3.995
2.19	4.097
2.00	4.169
1.50	4.365
Sept. 2, a. m.	
3.01	3.802
2.50	3.962
2.20	4.072
2.00	4.131
1.50	4.328
Sept. 3, a. m.	
3.00	3.853
2.49	4.016
2.19	4.111
1.99	4.174
1.50	4.343
Sept. 4, a. m.	
2.19	3.766
Sept. 5, a. m.	
2.97	3.769
2.50	3.913
2.20	4.016
2.00	4.079
1.50	4.250
Sept. 6, a. m.	
2.99	3.681
2.51	3.859
2.20	3.980
2.00	4.045
1.50	4.217

1928	
M.	R.
Sept. 10, a. m.	
2.01	3.908
1.80	4.020
1.60	4.142
1.50	4.198
1.43	4.240
Sept. 10, p. m.	
2.05	3.978
1.88	4.036
1.76	4.080
Sept. 11, a. m.	
3.00	3.819
2.49	3.992
2.19	4.100
2.00	4.173
1.50	4.367
Sept. 12, a. m.	
1.80	4.231
1.60	4.327
1.50	4.353
1.43	4.367
1.38	4.385
Sept. 13, a. m.	
2.50	3.940
2.20	4.046
1.99	4.130
1.80	4.200
1.50	4.317
Sept. 14, a. m.	
1.12	4.471
1.11	4.498
Sept. 15, a. m.	
1.77	4.234
1.57	4.335
1.45	4.350
Sept. 16, a. m.	
2.99	3.945
2.50	4.095
2.20	4.174
2.00	4.266
1.50	4.467
Sept. 17, a. m.	
2.50	4.092
2.19	4.189
2.00	4.289
1.80	4.344
1.50	4.455
Sept. 19, a. m.	
1.27	4.241
1.21	4.326

1928	
M.	R.
Sept. 20, a. m.	
4.95	3.116
3.86	3.395
3.00	3.634
2.50	3.784
2.00	3.982
1.50	4.194
Sept. 21, a. m.	
2.99	3.868
2.50	4.036
2.19	4.150
2.00	4.219
1.50	4.410
Sept. 22, a. m.	
1.20	4.361
Sept. 23, a. m.	
3.01	3.665
2.50	3.842
1.99	4.034
1.80	4.100
1.50	4.254
Sept. 24, a. m.	
2.04	4.093
1.79	4.208
1.69	4.259
1.51	4.331
1.44	4.365
Sept. 26, a. m.	
2.99	3.707
2.50	3.895
2.19	4.018
1.80	4.180
1.66	4.244
Sept. 27, a. m.	
2.98	3.857
2.49	4.019
2.19	4.123
2.00	4.188
1.50	4.366
Sept. 29, a. m.	
3.00	3.612
2.50	3.788
2.19	3.907
2.00	3.980
1.50	4.182
Sept. 30, a. m.	
2.50	3.664
2.20	3.765
2.01	3.823
1.70	3.986
1.50	4.070
Oct. 1, a. m.	
1.31	4.341
1.23	4.379
1.17	4.417
1.14	4.396

1928	
M.	R.
Oct. 2, a. m.	
4.89	2.992
3.87	3.326
2.98	3.641
2.49	3.802
2.00	4.026
1.50	4.242
Oct. 3, a. m.	
2.98	3.738
2.00	4.079
1.79	4.169
1.60	4.249
1.50	4.293
Oct. 4, a. m.	
2.98	3.714
2.51	3.868
2.19	4.011
2.00	4.037
1.50	4.217
Oct. 5, a. m.	
3.01	3.732
2.50	3.880
1.80	4.095
Oct. 6, a. m.	
3.01	3.848
2.50	4.034
2.00	4.224
1.80	4.300
1.50	4.424
Oct. 7, a. m.	
3.01	3.804
2.50	3.974
1.99	4.150
1.80	4.213
1.50	4.340
Oct. 8, a. m.	
3.01	3.784
2.50	3.932
2.00	4.154
1.80	4.245
1.50	4.381
Oct. 9, a. m.	
4.95	3.159
3.91	3.421
3.01	3.665
2.51	3.907
2.00	4.126
1.50	4.362
Oct. 10, a. m.	
2.99	3.938
2.49	4.074
2.00	4.248
1.80	4.344
1.50	4.457

1928	
M.	R.
Oct. 11, a. m.	
3.02	3.911
2.49	4.092
2.00	4.256
1.80	4.326
1.50	4.464
Oct. 12, a. m.	
2.99	3.836
2.50	3.992
2.00	4.186
1.80	4.268
1.50	4.390
Oct. 13, a. m.	
2.90	3.683
2.50	3.842
2.00	4.055
1.79	4.150
1.51	4.268
Oct. 14, a. m.	
3.00	3.733
2.50	3.893
2.00	4.098
1.80	4.185
1.50	4.315
Oct. 15, a. m.	
3.00	3.775
2.50	3.959
2.01	4.133
1.80	4.225
1.50	4.363
Oct. 16, a. m.	
1.71	4.207
Oct. 18, a. m.	
3.01	3.568
2.50	3.780
2.00	3.986
1.80	4.077
1.50	4.232
Oct. 19, a. m.	
4.90	3.235
3.88	3.483
3.00	3.724
2.50	3.908
2.00	4.101
1.50	4.325
Oct. 20, a. m.	
1.18	4.406
1.15	4.410
1.10	4.424
Oct. 21, a. m.	
1.62	4.402

1928	
M.	R.
Oct. 22, a. m.	
3.03	3.917
2.21	4.208
2.02	4.288
1.83	4.371
1.70	4.426
Oct. 24, a. m.	
3.01	3.858
2.51	4.018
2.01	4.192
1.80	4.283
1.50	4.405
Oct. 25, a. m.	
2.98	3.835
2.50	3.999
2.00	4.178
1.80	4.265
1.50	4.404
Oct. 26, a. m.	
3.00	3.733
2.50	3.915
2.01	4.106
1.81	4.200
1.50	4.348
Oct. 27, a. m.	
3.01	3.597
2.51	3.790
2.00	4.018
1.80	4.114
1.50	4.265
Oct. 28, a. m.	
2.99	3.699
2.50	3.879
2.00	4.078
1.80	4.163
1.50	4.290
Oct. 29, a. m.	
4.98	3.221
3.89	3.499
3.00	3.784
2.50	3.908
2.01	4.148
1.50	4.346
Oct. 30, a. m.	
3.01	3.748
2.50	3.922
2.00	4.121
1.80	4.212
1.50	4.366
Oct. 31, a. m.	
3.00	3.747
2.50	3.927
2.01	4.113
1.80	4.198
1.50	4.320

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1928	
M.	R.
Nov. 1, a. m.	
2.89	3.767
2.52	3.905
2.00	4.093
1.80	4.169
1.50	4.350
Nov. 2, a. m.	
3.00	3.736
2.50	3.940
2.01	4.121
1.80	4.229
1.50	4.389
Nov. 3, a. m.	
3.01	3.542
2.52	3.730
2.00	3.968
1.80	4.063
1.50	4.266
Nov. 4, a. m.	
3.00	3.643
2.51	3.796
2.20	3.893
2.01	3.959
1.80	4.014
Nov. 8, a. m.	
3.01	3.828
2.51	4.009
2.00	4.225
1.80	4.324
1.50	4.483
Nov. 9, a. .m	
3.00	3.908
2.50	4.056
2.01	4.206
1.71	4.353
1.50	4.436
Nov. 10, a. m.	
3.01	3.852
2.50	4.041
2.01	4.234
1.70	4.365
1.50	4.449
Nov. 11, a. m.	
3.01	3.764
2.51	3.941
Nov. 12, a. m.	
2.50	3.926
2.01	4.126
1.80	4.212
1.60	4.300
1.50	4.343

1928	
M.	R.
Nov. 13, a. m.	
2.50	3.873
2.01	4.093
1.80	4.188
1.60	4.284
1.47	4.347
Nov. 14, a. m.	
2.98	3.730
2.49	3.915
1.99	4.142
1.80	4.248
1.49	4.379
Nov. 16, a. m.	
1.20	4.542
1.16	4.551
1.13	4.574
1.09	4.595
1.07	4.608
Nov. 17, a. m.	
1.10	4.593
1.12	4.601
Nov. 18, a. m.	
1.96	4.186
1.81	4.246
1.60	4.339
1.50	4.385
1.43	4.418
Nov. 19. a. m.	
1.16	4.608
1.13	4.634
1.10	4.655
1.07	4.666
Nov. 20, a. m.	
2.33	3.908
2.11	4.018
1.90	4.111
1.71	4.189
1.61	4.238
Nov. 22, a. m.	
4.90	3.166
3.94	3.447
3.02	3.679
2.50	3.892
2.02	4.110
1.50	4.347
Nov. 23, a. m.	
3.01	3.736
2.50	3.931
2.00	4.132
1.80	4.213
1.51	4.343

1928	
M.	R.
Nov. 24, a. m.	
3.01	3.802
2.50	3.949
2.20	4.077
2.01	4.168
1.85	4.230
Nov. 25, a. m.	
3.00	3.731
2.50	3.888
2.00	4.107
1.80	4.169
1.50	4.335
Nov. 26, a. m.	
3.01	3.595
2.50	3.754
2.00	3.986
1.80	4.128
1.50	4.250
Nov. 27, a. m.	
4.98	3.084
4.02	3.341
3.01	3.645
2.50	3.853
2.00	4.061
1.50	4.291
Nov. 28, a. m.	
1.88	4.080
1.70	4.172
1.60	4.226
1.50	4.274
1.40	4.326
Nov. 29, a. m.	
2.50	3.770
2.00	4.016
1.80	4.113
1.61	4.219
1.50	4.280
Nov. 30, a. m.	
1.14	4.513
1.11	4.523
1.08	4.578
1.06	4.588
1.05	4.593
Dec. 1, a. m.	
3.01	3.930
2.50	4.081
1.99	4.266
1.80	4.359
1.50	4.515
Dec. 3, a. m.	
1.31	4.397
1.26	4.420
1.21	4.436

1928	
M.	R.
Dec. 4, a. m.	
3.02	3.481
2.51	3.709
2.00	3.951
1.80	4.053
1.50	4.209
Dec. 5, a. m.	
4.92	2.512
3.99	2.832
3.03	3.220
2.50	3.465
2.00	3.736
1.50	4.111
Dec. 6, a. m.	
3.00	3.420
2.49	3.620
2.00	3.857
1.80	3.960
1.50	4.158
Dec. 7, a. m.	
3.00	3.473
2.50	3.660
2.00	4.893
1.80	4.011
1.50	4.188
Dec. 8, a. m.	
3.01	3.489
2.51	3.713
1.99	3.965
1.80	4.057
1.50	4.245
Dec. 9, a. m.	
1.37	4.222
1.24	4.349
1.21	4.385
Dec. 12, a. m.	
1.06	4.647
1.05	4.636
Dec. 13, a. m.	
4.90	3.355
3.99	3.518
3.03	3.818
2.50	3.989
2.00	4.200
1.50	4.430
Dec. 14, a. m.	
3.00	3.855
2.50	4.045
2.00	4.260
1.80	4.342
1.69	4.406

1928	
M.	R.
Dec. 15, a. m.	
3.02	3.794
2.51	3.993
2.00	4.225
1.80	4.311
1.50	4.486
Dec. 16, a. m.	
3.00	3.788
2.50	3.981
2.00	4.182
1.80	4.282
1.50	4.450
Dec. 17, a. m.	
3.01	3.819
2.50	3.987
2.00	4.205
1.80	4.311
1.50	4.483
Dec. 18, a. m.	
2.99	3.852
2.49	4.036
2.00	4.240
1.80	4.329
1.50	4.472
Dec. 19, a. m.	
3.00	3.705
2.50	3.913
2.00	4.115
1.80	4.221
1.50	4.385
Dec. 20, a. m.	
4.94	3.149
4.01	3.403
3.01	3.743
2.50	3.920
2.00	4.150
1.50	4.355
Dec. 21, a. m.	
2.99	3.699
2.50	3.875
2.00	4.094
1.80	4.186
1.50	4.324
Dec. 22, a. m.	
3.04	3.678
2.52	3.897
2.00	4.133
1.81	4.225
1.61	4.323
Dec. 23, a. m.	
2.96	3.632
2.42	3.853
2.01	4.025
1.78	4.129
1.61	4.227

1928	
M.	R.
Dec. 24, a. m.	
1.61	4.186
1.48	4.253
1.38	4.310
1.28	4.365
1.21	4.399
Dec. 25, a. m.	
2.90	3.563
2.45	3.750
2.01	3.958
1.80	4.058
1.61	4.156
Dec. 26, a. m.	
1.73	4.258
1.57	4.357
1.44	4.443
1.33	4.484
1.26	4.490
Dec. 27, a. m.	
3.04	3.766
2.53	3.952
Dec. 30, a. m.	
1.02	4.451
1.01	4.418
1929	
M.	R.
Jan. 2, a. m.	
2.38	3.882
2.20	3.952
2.05	4.016
Jan. 5, a. m.	
1.80	3.890
1.69	3.962
1.59	4.019
1.50	4.077
1.40	4.109
Jan. 7, a. m.	
1.13	4.303
1.10	4.308
1.08	4.308
1.07	4.356
1.05	4.360
Jan. 10, a. m.	
1.55	4.211
1.40	4.292
1.34	4.326
Jan. 14, a. m.	
1.80	4.004
1.50	4.169

1929	
M.	R.
Jan. 15, a. m.	
3.00	3.506
2.50	3.693
2.00	3.916
1.80	4.001
1.50	4.126
Jan. 16, a. m.	
2.99	3.554
2.49	3.766
2.01	3.981
1.80	4.075
1.50	4.207
Jan. 17, a. m.	
4.98	3.121
4.02	3.396
3.00	3.713
2.50	3,895
2.00	4.118
1.50	4.357
Jan. 20, a. m.	
1.47	4.258
1.41	4.284
1.34	4.307
1.28	4.331
1.23	4.360
Jan. 21, a. m.	
1.36	4.247
1.31	4.285
1.24	4.333
1.20	4.365
1.16	4.387
Jan. 22, a. m.	
1.45	4.152
1.38	4.188
1.31	4.232
1.27	4.256
Jan. 23, p. m.	
1.02	4.259
1.03	4.271
Jan. 28, a. m.	
2.49	3.849
2.00	4.055
1.80	4.159
1.50	4.313
Jan. 30, a. m.	
2.44	3.785
2.00	3.981
1.80	4.072
1.50	4.238
Jan. 31, a. m.	
1.37	4.344
1.30	4.383
1.25	4.411

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1929 M.	R.
Feb. 1, a. m.	
1.06	4.439
1.05	4.457
1.04	4.476
Feb. 2, a. m.	
1.50	4.287
1.38	4.322
1.30	4.367
Feb. 3, a. m.	
1.07	4.521
1.04	4.558
Feb. 5, a. m.	
4.89	2.861
3.96	3.137
2.99	3.461
2.50	3.650
2.00	3.866
1.50	4.116
Feb. 6, a. m.	
1.51	4.001
1.40	4.088
1.30	4.167
Feb. 7, a. m.	
2.91	3.467
2.43	3.664
1.99	3.855
1.77	3.976
1.60	4.067
Feb. 8, a. m.	
2.99	3.527
2.50	3.721
1.99	3.950
1.80	4.052
1.50	4.216
Feb. 9, a. m.	
3.00	3.595
2.48	3.782
2.00	3.963
1.80	4.039
1.50	4.187
Feb. 10, a. m.	
3.01	3.483
2.49	3.673
2.00	3.894
1.80	3.988
1.50	4.138
Feb. 11, a. m.	
2.99	3.438
2.50	3.650
2.00	3.877
1.79	3.979
1.50	4.122

1929 M.	R.
Feb. 12, a. m.	
3.00	3.459
2.50	3.671
2.00	3.903
1.80	3.997
1.50	4.142
Feb. 13, a. m.	
2.97	3.499
2.49	3.656
1.98	3.916
Feb. 14, a. m.	
2.99	3.566
2.35	3.815
1.89	4.013
1.59	4.145
Feb. 15, a. m.	
1.08	4.352
1.06	4.360
1.04	4.368
Feb. 16, a. m.	
3.02	3.185
2.41	3.461
1.98	3.687
1.72	3.832
Feb. 21, a. m.	
3.00	3.253
2.47	3.487
2.00	3.715
1.79	3.823
1.50	3.978
Feb. 22, a. m.	
3.01	3.238
2.51	3.455
2.00	3.698
1.80	3.809
1.61	3.913
Feb. 23, a. m.	
3.01	3.377
2.49	3.631
2.20	3.779
2.00	3.802
1.50	4.129
Feb. 24, a. m.	
2.99	3.345
2.50	3.563
2.20	3.732
2.00	3.829
1.80	3.945
Feb. 25, a. m.	
2.97	3.655
2.50	3.815
2.20	3.925
2.00	4.007
1.50	4.245

1929 M.	R.
Feb. 26, a. m.	
1.09	4.294
Mar. 1, a. m.	
1.40	3.926
1.33	3.985
1.28	4.044
1.21	4.104
1.17	4.131
Mar. 4, a. m.	
2.00	3.735
Mar. 5, a. m.	
2.99	3.375
2.50	3.565
2.20	3.704
1.70	3.952
1.56	4.025
Mar. 6, a. m.	
1.87	3.819
1.70	3.913
1.60	3.977
1.50	4.020
1.43	4.105
Mar. 7, a. m.	
1.44	4.009
1.39	4.046
Mar. 8, a. m.	
1.45	3.963
1.38	4.000
1.31	4.046
1.26	4.091
1.22	4.124
Mar. 9, a. m.	
2.98	3.235
2.49	3.488
2.20	3.628
1.39	4.018
1.33	4.066
Mar. 10, a. m.	
1.13	4.246
Mar. 11, a. m.	
1.28	4.154
1.09	2.247
Mar. 12, a. m.	
3.00	3.435
2.51	3.597
2.19	3.767
2.00	3.854
1.86	3.936
Mar. 13, a. m.	
1.40	4.166
1.22	4.258
1.19	4.266

1929 M.	R.
Mar. 14, a. m.	
4.94	2.830
4.03	3.089
3.01	3.405
2.49	3.593
2.00	3.818
1.50	4.072
Mar. 15, a. m.	
2.99	3.510
2.50	3.731
2.20	3.819
2.00	3.912
1.50	4.150
Mar. 16, a. m.	
3.00	3.485
2.50	3.695
2.19	3.822
2.00	3.911
1.50	4.168
Mar. 17, a. m.	
3.01	3.507
2.50	3.705
2.20	3.827
2.00	3.909
1.50	4.171
Mar. 18, a. m.	
3.01	3.565
2.49	3.756
2.20	3.874
2.00	3.977
1.50	4.230
Mar. 19, a. m.	
4.94	2.963
4.04	3.208
3.01	3.534
2.50	3.737
2.00	3.948
1.50	4.178
Mar. 20, a. m.	
2.99	3.670
2.50	3.847
2.21	3.960
2.00	4.035
1.50	4.268
Mar. 21, a. m.	
3.00	3.633
2.50	3.807
2.20	3.899
2.00	3.995
1.80	4.092
1.50	4.244
Mar. 22, a. m.	
3.01	3.682
2.51	3.840
2.20	3.961
2.01	4.034
1.50	4.283

1929 M.	R.
Mar. 23, a. m.	
4.91	3.140
4.02	3.375
3.01	3.664
2.50	3.838
2.00	4.051
1.50	4.268
Mar. 24, a. m.	
2.99	3.595
2.50	3.780
2.21	3.928
2.00	3.986
1.50	4.224
Mar. 25, a. m.	
2.99	3.532
2.51	3.715
2.20	3.839
2.00	3.925
1.50	4.174
Mar. 27, a. m.	
2.19	3.733
1.66	3.932
1.57	3.976
1.50	4.018
1.43	4.083
1.37	4.125
Mar. 30, a. m.	
2.13	3.699
1.97	3.768
1.70	3.884
Mar. 31, a. m.	
3.01	3.483
2.50	3.662
2.01	3.888
Apr. 1, a. m.	
3.01	3.529
2.50	3.722
1.97	3.956
1.68	4.083
1.50	4.169
Apr. 2, a. m.	
3.00	3.634
2.49	3.818
1.98	4.037
1.80	4.125
1.62	4.207
Apr. 3, a. m.	
2.95	3.588
2.50	3.749
2.00	3.946
1.70	4.064
1.50	4.196

1929 M.	R.
Apr. 4, a. m.	
2.50	3.809
2.18	3.936
1.97	4.019
1.78	4.098
1.51	4.224
Apr. 5, a. m.	
4.98	2.923
4.00	3.238
3.02	3.550
2.50	3.748
2.00	3.945
1.50	4.193
Apr. 6, a. m.	
2.99	3.617
2.51	3.768
2.22	3.926
2.02	3.962
1.81	4.067
1.50	4.193
Apr. 7, a. m.	
1.28	4.341
1.25	4.365
1.22	4.375
1.20	4.390
1.18	4.388
Apr. 8, a. m.	
2.97	3.631
2.50	3.784
2.19	3.886
2.00	3.974
1.50	4.212
Apr. 9, a. m.	
2.99	3.635
2.50	3.817
2.20	3.909
2.00	3.981
1.50	4.231
Apr. 10, a. m.	
2.79	3.873
2.50	3.965
2.20	4.074
2.01	4.133
1.89	4.180
Apr. 11, a. m.	
4.99	3.327
4.02	3.555
3.00	3.829
2.50	3.995
1.99	4.172
1.50	4.357
Apr. 12, a. m.	
3.05	3.800
2.49	3.990
1.24	4.499
1.21	4.506
1.20	4.531

1929 M.	R.
Apr. 13, a. m.	
2.99	3.740
2.50	3.906
2.19	4.016
2.00	4.075
1.50	4.285
Apr. 14, a. m.	
3.01	3.796
2.49	3.979
2.20	4.074
2.01	4.143
1.50	4.342
Apr. 15, a. m.	
1.80	4.215
1.70	4.264
1.60	4.324
1.50	4.365
1.44	4.391
Apr. 16, a. m.	
4.95	3.297
4.00	3.533
3.00	3.817
2.49	3.984
2.00	4.162
1.50	4.375
Apr. 17, a. m.	
3.01	3.853
2.50	4.030
2.20	4.132
2.00	4.198
1.50	4.344
Apr. 18, a. m.	
2.97	3.785
2.49	3.938
2.19	4.064
2.00	4.129
1.50	4.356
Apr. 19, a. m.	
2.98	3.713
2.48	3.868
2.20	3.981
1.99	4.074
1.50	4.320
Apr. 20, a. m.	
3.00	3.855
2.48	4.046
2.20	4.131
1.99	4.207
1.50	4.413
Apr. 21, a. m.	
2.98	3.845
2.50	3.964
2.20	4.070
2.01	4.135
1.50	4.330

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1929 M.	R.
Apr. 22, a. m.	
4.96	3.273
3.98	3.528
3.00	3.804
2.52	3.956
2.01	4.116
1.50	4.331
Apr. 23, a. m.	
3.00	3.687
2.50	3.866
2.19	3.972
2.01	4.036
1.50	4.284
Apr. 24, a. m.	
2.91	3.659
2.49	3.806
2.20	3.915
2.00	3.998
1.50	4.207
Apr. 25, a. m.	
3.00	3.663
2.51	3.828
2.20	3.943
2.00	4.017
1.50	4.226
Apr. 26, a. m.	
3.00	3.745
2.50	3.908
2.20	4.014
2.00	4.085
1.80	4.152
Apr. 27, a. m.	
4.98	3.163
3.99	3.407
3.00	3.699
2.48	3.872
2.00	4.060
1.50	4.285
Apr. 28, a. m.	
3.00	3.659
2.49	3.839
2.20	3.961
2.00	4.051
1.50	4.249
Apr. 29, a. m.	
3.01	3.625
2.50	3.789
2.20	3.893
2.00	3.967
1.50	4.165
Apr. 30, a. m.	
3.01	3.676
2.50	3.831
2.20	3.946
2.00	4.023
1.50	4.249

1929 M.	R.
May 1, a. m.	
2.99	3.695
2.50	3.854
2.20	3.968
2.00	4.050
1.50	4.269
May 2, a. m.	
3.20	3.581
2.81	3.711
2.50	3.809
2.20	3.912
2.00	3.983
May 3, a. m.	
3.00	3.638
2.50	3.830
2.20	3.931
2.00	3.999
1.50	4.176
May 4, a. m.	
3.01	3.610
2.50	3.768
2.20	3.886
2.00	3.967
1.50	4.177
May 5, a. m.	
4.95	3.036
4.00	3.263
3.00	3.575
2.50	3.752
2.00	3.942
1.50	4.179
May 6, a. m.	
3.17	3.599
1.43	4.242
1.40	4.255
May 10, a. m.	
2.98	3.680
2.50	3.828
2.00	3.999
1.80	4.088
1.50	4.207
May 11, a. m.	
4.96	3.220
3.99	3.453
3.00	3.716
May 12, a. m.	
2.12	3.910
May 13, p. m.	
2.65	3.795
2.42	3.897
2.24	3.979

1929 M.	R.
May 14, a. m.	
3.02	3.605
2.50	3.783
2.21	3.881
2.01	3.972
1.50	4.204
May 15, a. m.	
2.22	3.815
2.04	3.886
1.79	4.018
May 17, a. m.	
4.97	3.170
4.03	3.388
2.99	3.664
2.50	3.807
2.00	4.002
1.50	4.186
May 18, a. m.	
2.50	3.984
2.20	4.093
2.00	4.168
1.80	4.243
1.50	4.375
May 19, a. m.	
3.00	3.616
2.50	3.779
2.20	3.881
2.01	3.946
1.80	4.020
May 20, a. m.	
2.99	3.541
2.57	3.661
2.23	3.782
1.98	3.890
1.80	3.963
May 22, a. m.	
3.00	3.561
2.50	3.731
2.20	3.836
2.00	3.909
1.80	3.999
May 23, a. m.	
4.94	3.034
4.05	3.266
3.00	3.561
2.50	3.713
2.00	3.891
1.50	4.102
May 24, a. m.	
3.01	3.523
2.50	3.707
2.20	3.820
2.00	3.897
1.50	4.142

1929 M.	R.
May 25, a. m.	
2.50	3.735
2.20	3.841
2.00	3.935
1.80	3.991
1.50	4.135
May 26, a. m.	
3.00	3.682
2.50	3.841
2.20	3.964
2.00	4.027
1.50	4.229
May 27, a. m.	
3.00	3.691
2.50	3.854
2.20	3.956
2.00	4.025
1.50	4.244
May 28, a. m.	
4.88	3.251
3.99	3.468
3.00	3.736
2.50	3.892
2.00	4.057
1.50	4.256
May 29, a. m.	
3.00	3.667
2.50	3.852
2.20	3.956
2.00	4.031
1.50	4.214
May 30, a. m.	
2.97	3.744
2.50	3.900
2.20	4.004
2.00	4.075
1.80	4.179
May 31, a. m.	
3.01	3.758
2.50	3.924
2.20	4.040
2.00	4.103
1.50	4.299
June 1, a. m.	
2.98	3.754
2.49	3.898
2.00	4.073
1.90	4.107
1.80	4.144
June 2, a. m.	
2.12	3.880
1.99	3.931
1.73	4.035

1929 M.	R.
June 3, a. m.	
3.00	3.671
2.50	3.821
2.20	3.927
2.00	4.000
1.50	4.225
June 4, a. m.	
2.50	3.718
2.20	3.829
2.00	3.899
1.80	3.973
1.70	4.034
June 5, a. m.	
5.01	3.038
4.04	3.253
3.00	3.532
2.50	3.695
2.00	3.888
1.50	4.109
June 6, a. m.	
3.00	3.660
2.50	3.803
2.19	3.893
2.00	3.951
1.50	4.140
June 7, a. m.	
1.43	4.119
1.42	4.192
1.42	4.208
June 11, a. m.	
2.98	3.598
2.49	3.762
2.20	3.863
2.00	3.932
1.50	4.141
June 12, a. m.	
4.90	3.149
4.01	3.373
3.01	3.622
2.50	3.769
2.00	3.938
1.50	4.140
June 13, a. m.	
2.87	3.610
2.50	3.749
2.18	3.874
2.00	3.946
1.80	4.027
June 14, a. m.	
3.00	3.589
2.49	3.766
2.20	3.870
2.00	3.943
1.80	4.017

1929 M.	R.
June 15, a. m.	
2.80	3.697
2.50	3.793
2.19	3.905
2.00	3.962
1.50	4.178
June 20, a. m.	
1.54	4.010
1.51	4.021
1.48	4.025
June 22, a. m.	
2.44	4.030
2.20	4.094
2.00	4.174
1.80	4.266
June 23, a. m.	
3.01	3.827
2.50	3.966
2.20	4.074
2.00	4.146
1.50	4.337
June 24, a. m.	
5.02	3.355
3.99	3.581
3.00	3.817
2.50	3.975
2.00	4.132
1.50	4.322
June 25, a. m.	
4.94	3.342
4.00	3.564
3.01	3.818
2.50	3.972
2.00	4.133
1.50	4.327
June 26, a. m.	
3.01	3.781
2.50	3.918
2.20	4.034
2.00	4.113
1.50	4.273
June 29, a. m.	
2.99	3.724
2.50	3.908
2.20	4.024
2.00	4.115
1.80	4.182
June 30, a. m.	
3.01	3.813
2.50	3.968
2.20	4.060
2.00	4.123
1.50	4.287

1929 M.	R.
July 1, a. m.	
4.82	3.177
3.99	3.359
3.01	3.622
2.49	3.790
2.00	3.964
1.50	4.151
July 2, a. m.	
3.04	3.631
2.51	3.822
2.21	3.925
2.01	3.977
July 3, a. m.	
2.21	3.874
2.01	3.969
1.91	3.997
1.81	4.054
1.70	4.097
July 4, a. m.	
2.52	3.944
2.22	4.050
2.01	4.123
1.81	4.198
1.50	4.337
July 5, a. m.	
3.03	3.672
2.52	3.838
2.21	3.938
2.01	4.009
1.50	4.188
July 6, a. m.	
5.02	3.020
4.02	3.253
3.00	3.548
2.50	3.689
2.00	3.908
1.50	4.090
July 7, a. m.	
1.60	4.113
1.55	4.134
1.52	4.135
July 8, a. m.	
2.99	3.578
2.50	3.743
2.20	3.854
1.99	3.929
1.80	4.021
July 9, a. m.	
3.00	3.580
2.50	3.747
2.31	3.812
2.18	3.856
1.98	3.917

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce the gram-calories per minute per cm², multiply R by 0.3629]

1929	
M.	R.
July 10, a. m.	
3.00	3.664
2.50	3.826
2.20	3.929
2.00	3.999
1.50	4.242
July 11, a. m.	
5.01	3.252
4.01	3.465
3.01	3.725
2.38	3.940
2.00	4.073
1.50	4.271
July 12, a. m.	
3.00	3.710
2.50	3.888
2.20	3.980
2.00	4.058
1.50	4.287
July 13, a. m.	
3.00	3.649
2.49	3.822
2.20	3.914
2.00	3.996
1.50	4.190
July 14, a. m.	
3.01	3.672
2.50	3.826
2.20	3.908
2.00	3.994
1.80	4.062
July 15, a. m.	
4.99	3.073
4.00	3.313
3.00	3.589
2.48	3.776
2.00	3.959
1.50	4.183
July 16, a. m.	
2.99	3.604
2.50	3.769
2.20	3.875
2.00	3.946
1.50	4.136
July 17, a. m.	
2.97	3.545
2.50	3.700
2.20	3.823
2.00	3.907
1.80	3.987
July 18, a. m.	
3.01	3.762
2.50	3.947
2.20	4.032
2.00	4.072

1929	
M.	R.
July 19, a. m.	
3.00	3.778
2.50	3.904
2.20	4.008
2.00	4.095
1.50	4.253
July 20, a. m.	
3.01	3.826
2.51	3.964
2.20	4.039
2.00	4.124
1.50	4.343
July 21, a. m.	
2.49	3.942
2.20	4.041
2.09	4.088
2.00	4.128
July 22, a. m.	
4.81	3.266
3.93	3.466
3.00	3.710
2.50	3.849
2.00	4.052
1.50	4.223
July 23, a. m.	
3.02	3.518
2.50	3.666
2.20	3.770
2.00	3.844
1.56	4.028
July 24, a. m.	
2.95	3.590
2.50	3.727
2.20	3.819
2.00	3.888
1.80	3.970
July 26, a. m.	
2.75	3.740
2.50	3.815
2.20	3.908
2.00	3.971
1.80	4.058
July 27, a. m.	
2.98	3.779
2.50	3.944
2.19	4.044
2.00	4.112
1.80	4.186
July 28, a. m.	
3.01	3.653
2.48	3.825
2.19	3.920
2.00	3.998
1.80	4.081

1929	
M.	R.
July 30, a. m.	
5.02	3.203
3.98	3.451
2.99	3.730
2.50	3.886
2.00	4.056
1.50	4.244
July 31, a. m.	
3.00	3.759
2.50	3.926
2.20	4.021
2.00	4.078
1.50	4.283
Aug. 2, a. m.	
3.01	3.617
2.50	3.787
2.20	3.869
2.00	3.958
1.50	4.146
Aug. 3, a. m.	
2.50	3.845
2.20	3.962
2.00	4.036
1.80	4.114
1.50	4.263
Aug. 4, a. m.	
3.00	3.803
2.50	3.983
2.20	4.078
2.00	4.160
1.50	4.346
Aug. 5, a. m.	
4.91	3.325
3.96	3.569
3.00	3.833
2.50	3.980
2.00	4.155
1.50	4.355
Aug. 6, a. m.	
3.00	3.780
2.50	3.925
2.20	4.014
2.00	4.095
1.50	4.264
Aug. 7, a. m.	
3.00	3.699
2.50	3.845
2.20	3.970
2.00	4.045
1.80	4.122
Aug. 8, a. m.	
3.00	3.716
2.50	3.888
2.20	3.999
2.00	4.076
1.80	4.152

1929	
M.	R.
Aug. 9, a. m.	
2.50	3.915
2.20	4.029
2.00	4.109
1.80	4.190
1.70	4.230
Aug. 10, a. m.	
3.01	3.781
2.50	3.962
2.20	4.044
1.99	4.133
1.50	4.306
Aug. 11, a. m.	
2.87	3.808
2.50	3.940
2.20	4.047
2.00	4.123
1.50	4.320
Aug. 12, a. m.	
2.98	3.832
2.50	3.962
2.20	4.063
2.00	4.132
1.50	4.356
Aug. 13, a. m.	
4.94	3.268
3.99	3.518
2.98	3.781
2.45	3.963
2.00	4.091
1.48	4.266
Aug. 14, a. m.	
3.01	3.536
2.49	3.731
2.20	3.860
1.99	3.917
1.50	4.143
Aug. 15, a. m.	
2.98	3.599
2.49	3.737
2.20	3.845
2.00	3.919
1.49	4.133
Aug. 16, a. m.	
3.01	3.642
2.51	3.814
2.20	3.925
2.00	3.998
1.50	4.216
Aug. 17, a. m.	
4.97	3.150
3.99	3.414
3.01	3.711
2.45	3.892
2.00	4.045
1.50	4.251

1929	
M.	R.
Aug. 18, a. m.	
2.15	4.046
1.66	4.239
1.59	4.265
Aug. 20, a. m.	
3.01	3.722
2.50	3.886
2.20	3.984
2.00	4.054
1.50	4.256
Aug. 21, a. m.	
3.00	3.723
2.50	3.890
2.20	3.997
2.00	4.068
1.50	4.254
Aug. 22, a. m.	
3.00	3.489
2.50	3.637
2.20	3.778
2.00	3.829
Aug. 23, a. m.	
3.00	3.553
2.50	3.718
2.20	3.845
2.00	3.936
1.80	4.027
Aug. 24, a. m.	
3.00	3.782
2.49	3.954
2.20	4.052
2.00	4.124
1.50	4.327
Aug. 25, a. m.	
5.01	3.353
3.97	3.596
3.00	3.846
2.51	3.985
2.00	4.168
1.50	4.338
Aug. 29, a. m.	
1.51	4.325
1.45	4.349
1.40	4.369
1.34	4.395
1.30	4.413
Aug. 30, a. m.	
3.00	3.963
2.49	4.131
2.20	4.231
2.00	4.298
1.50	4.477

192	
M.	R.
Aug. 31, a. m.	
3.00	3.862
2.50	4.013
2.20	4.121
2.00	4.196
1.50	4.384
Sept. 1, a. m.	
3.00	3.580
1.76	4.037
1.64	4.085
Sept. 4, a. m.	
4.94	3.100
3.98	3.324
3.01	3.628
2.49	3.802
2.00	3.974
1.50	4.190
Sept. 5, a. m.	
2.98	3.770
2.48	3.943
2.20	4.061
2.00	4.121
1.50	4.298
Sept. 6, a. m.	
2.97	3.735
2.50	3.890
2.19	4.036
2.00	4.128
1.50	4.389
Sept. 7, a. m.	
3.00	3.854
2.50	4.024
2.20	4.119
2.00	4.199
1.50	4.397
Sept. 8, a. m.	
2.97	3.777
2.50	3.929
2.20	4.043
2.01	4.115
1.50	4.317
Sept. 9, a. m.	
5.01	3.229
4.01	3.466
2.99	3.761
2.51	3.936
2.00	4.128
1.50	4.325
Sept. 10, a. m.	
2.49	3.945
2.20	4.045
2.00	4.116
1.80	4.197
1.67	4.250

1929	
M.	R.
Sept. 11, a. m.	
2.50	3.892
2.20	4.000
2.00	4.071
1.80	4.148
1.50	4.288
Sept. 12, a. m.	
3.00	3.778
2.50	3,955
2.20	4.064
2.00	4.139
1.50	4.338
Sept. 13, a. m.	
3.00	3.889
2.50	4.056
2.19	4.156
2.00	4.238
1.50	4.414
Sept. 14, a. m.	
4.94	3.352
4.03	3.572
3.00	3.872
2.51	4.026
2.00	4.210
1.50	4.405
Sept. 15, a. m.	
2.98	3.802
2.50	3,955
2.20	4.079
2.00	4.141
1.50	4.259
Sept. 16, a. m.	
2.98	3.600
2.50	3.767
2.20	3.897
2.00	3.985
1.50	4.218
Sept. 17, a. m.	
1.11	4.446
1.12	4.435
Sept. 18, a. m.	
3.01	3.735
2.50	3.896
2.19	4.019
2.00	4.097
1.79	4.189
Sept. 19, a. m.	
3.01	3.819
2.49	3.966
2.20	4.066
2.00	4.183
1.50	4.354

Table 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1929	
M.	R.
Sept. 20, a. m.	
2.94	3.773
2.49	3.886
2.20	3.997
2.00	4.092
1.50	4.295
Sept. 21, a. m.	
4.96	3.154
4.04	3.397
3.00	3.697
2.60	3.845
2.20	3.997
2.00	4.076
1.50	4.281
Sept. 22, a. m.	
4.97	3.024
4.05	3.239
3.00	3.558
2.50	3.748
2.00	3.945
1.50	4.180
Sept. 23, a. m.	
2.99	3.758
2.11	4.060
1.94	4.122
1.80	4.205
1.50	4.336
Sept. 24, a. m.	
2.43	3.901
2.19	4.003
2.00	4.072
1.80	4.141
1.50	4.272
Sept. 25, a. m.	
3.02	3.731
2.50	3.906
2.20	4.035
2.01	4.130
1.50	4.343
Sept. 26, a. m.	
3.01	3.740
2.50	3.918
2.20	4.027
2.00	4.100
1.50	4.302
Sept. 27, a. m.	
2.20	3.909
1.94	4.034
1.80	4.086
1.69	4.130
Sept. 28, a. m.	
3.01	3.621
2.50	3.775
2.20	3.896
2.00	3.981
1.50	4.202

1929	
M.	R.
Sept. 29, a. m.	
4.98	3.250
4.02	3.478
3.00	3.784
2.49	3.970
2.00	4.155
1.50	4.355
Sept. 30, a. m.	
3.01	3.663
2.49	3.821
2.20	3.945
2.00	4.031
1.50	4.266
Oct. 1, a. m.	
3.00	3.647
2.50	3.818
2.20	3.955
2.00	4.077
1.80	4.154
Oct. 2, a. m.	
3.00	3.796
2.50	3.955
2.20	4.065
2.00	4.122
1.50	4.360
Oct. 3, a. m.	
3.00	3.890
2.50	4.035
2.20	4.151
2.00	4.235
1.50	4.426
Oct. 4, a. m.	
3.00	3.809
2.50	3.974
2.20	4.077
2.00	4.158
1.50	4.387
Oct. 5, a. m.	
4.90	3.287
4.01	3.476
3.00	3.797
2.50	3.968
2.00	4.150
1.50	4.393
Oct. 6, a. m.	
2.96	3.946
2.48	4.102
2.00	4.266
1.79	4.340
1.60	4.416
Oct. 7, a. m.	
3.01	3.774
2.51	3.990
2.20	4.102
2.00	4.160
1.50	4.347

1929	
M.	R.
Oct. 8, a. m.	
3.02	3.741
2.49	3.917
2.20	4.020
2.00	4.102
1.50	4.351
Oct. 9, a. m.	
2.85	4.004
2.49	4.105
2.20	4.214
2.00	4.289
1.50	4.467
Oct. 11, a. m.	
1.70	4.385
1.61	4.419
1.51	4.457
1.44	4.482
1.37	4.508
Oct. 14, a. m.	
1.73	4.249
1.57	4.317
1.45	4.367
Oct. 15, p. m.	
1.04	4.520
1.05	4.561
Oct. 16, a. m.	
2.49	3.981
2.20	4.100
2.00	4.182
1.80	4.233
1.50	4.400
Oct. 17, a. m.	
4.93	3.196
4.00	3.475
3.00	3.748
2.49	3.931
2.00	4.129
1.50	4.345
Oct. 18, a. m.	
2.49	3.832
2.20	3.936
2.00	4.016
1.80	4.099
1.50	4.225
Oct. 21, a. m.	
1.18	4.527
1.14	4.576
1.12	4.566
Oct. 22, a. m.	
2.20	4.067
2.00	4.160
1.80	4.261
Oct. 23, a. m.	
3.02	3.882

1929	
M.	R.
Oct. 26, a. m.	
3.01	3.346
2.49	3.540
2.20	3.701
2.00	3.795
1.80	3.890
Oct. 27, a. m.	
2.20	3.844
2.00	3.934
1.79	4.025
1.68	4.068
1.50	4.141
Oct. 28, a. m.	
1.16	4.404
1.14	4.422
1.11	4.398
Nov. 1, a. m.	
1.92	4.036
1.80	4.081
1.60	4.201
1.50	4.263
1.43	4.305
Nov. 2, a. m.	
5.00	3.052
4.00	3.288
3.00	3.633
2.63	3.746
2.28	3.879
2.00	4.026
1.50	4.224
Nov. 3, a. m.	
2.99	3.756
2.50	3.927
1.99	4.152
1.75	4.266
1.58	4.348
Nov. 4, a. m.	
4.99	3.438
4.01	3.667
3.01	3.939
2.49	4.102
2.00	4.288
1.50	4.503
Nov. 5, a. m.	
2.74	3.977
2.50	4.048
2.19	4.143
2.00	4.240
1.86	4.314
Nov. 6, a. m.	
3.00	3.916
2.49	4.109
2.20	4.222
2.00	4.303

1929	
M.	R.
Nov. 7, a. m.	
3.03	3.952
2.70	4.051
2.10	4.239
1.94	4.310
1.82	4.365
Nov. 8, a. m.	
2.98	3.929
2.50	4.087
2.20	4.196
2.00	4.274
1.50	4.475
Nov. 9, a. m.	
4.94	3.386
3.98	3.621
3.00	3.909
2.49	4.098
2.00	4.285
1.50	4.489
Nov. 10, a. m.	
2.99	3.918
2.50	4.050
2.21	4.169
1.99	4.230
1.50	4.453
Nov. 11, a. m.	
3.01	3.917
2.50	4.081
2.20	4.186
2.00	4.261
1.50	4.496
Nov. 12, a. m.	
3.00	3.922
2.51	4.097
2.20	4.210
2.00	4.286
1.50	4.481
Nov. 13, a. m.	
4.98	2.457
4.02	2.917
3.00	3.442
2.50	3.688
2.00	3.950
1.50	4.240
Nov. 14, a. m.	
1.50	4.465
1.39	4.508
1.30	4.541
1.23	4.571
1.17	4.581
Nov. 15, a. m.	
2.97	3.826
2.49	4.010
1.99	4.210
1.79	4.294
1.51	4.411

1929	
M.	R.
Nov. 16, a. m.	
1.52	4.317
1.40	4.361
1.32	4.387
Nov. 18, a. m.	
3.01	3.506
2.51	3.711
2.00	3.912
1.79	3.997
1.50	4.164
Nov. 19, a. m.	
1.72	4.200
Nov. 20, a. m.	
2.93	3.787
2.49	3.935
2.20	4.034
1.99	4.106
1.80	4.197
Nov. 21, a. m.	
2.08	4.065
1.94	4.131
1.72	4.235
1.62	4.283
1.50	4.342
Nov. 23, a. m.	
1.70	4.347
1.60	4.393
1.42	4.471
1.37	4.497
Nov. 24, a. m.	
4.94	3.311
4.00	3.555
2.99	3.868
2.51	4.026
2.00	4.217
1.50	4.455
Nov. 25, a. m.	
3.02	3.821
2.49	4.034
2.19	4.135
1.99	4.226
1.50	4.428
Nov. 26, a. m.	
2.99	3.890
2.51	4.058
2.20	4.176
2.00	4.261
1.50	4.480
Nov. 27, a. m.	
2.99	3.949
2.51	4.105
2.20	4.234
2.01	4.314
1.50	4.538

1929	
M.	R.
Nov. 28, a. m.	
2.99	3.838
2.49	4.026
2.20	4.138
1.99	4.221
1.50	4.424
Nov. 29, a. m.	
4.94	3.313
3.99	3.558
3.00	3.870
2.49	4.051
2.00	4.255
1.50	4.475
Dec. 2, a. m.	
1.18	4.509
1.13	4.539
1.11	4.565
Dec. 3, a. m.	
1.30	4.565
Dec. 4, a. m.	
3.01	3.892
2.50	4.087
2.20	4.206
2.00	4.291
1.80	4.374
Dec. 5, a. m.	
4.99	3.233
4.04	3.501
3.01	3.821
2.51	3.989
1.99	4.207
1.50	4.422
Dec. 6, a. m.	
2.99	3.740
2.51	3.921
2.21	4.041
2.00	4.128
1.80	4.209
Dec. 7, a. m.	
3.00	3.713
2.50	3.892
2.19	4.003
2.00	4.103
1.80	4.189
Dec. 8, a. m.	
2.87	3.832
Dec. 9, a. m.	
1.97	4.247
1.84	4.309
1.72	4.369
1.61	44.42
1.44	3.474

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1929	
M.	R.
Dec. 10, a. m.	
3.01	3.778
2.49	3.958
2.21	4.074
2.00	4.161
1.50	4.400
Dec. 11, a. m.	
5.01	3.246
3.99	3.501
3.00	3.798
2.50	3.990
2.00	4.178
1.50	4.406
Dec. 12, a. m.	
3.00	3.844
2.50	4.029
2.20	4.148
2.00	4.227
1.50	4.477
Dec. 13, a. m.	
2.99	3.893
2.49	4.088
2.19	4.204
2.00	4.285
1.50	4.500
Dec. 14, a. m.	
1.58	4.358
1.49	4.400
1.42	4.431
1.36	4.463
1.30	4.490
Dec. 16, a. m.	
1.20	4.425
1.17	4.446
1.14	4.460
1.11	4.478
Dec. 17, p. m.	
1.04	4.393
Dec. 18, p. m.	
1.05	4.550
1.04	4.548
1.03	4.551
Dec. 19, a. m.	
4.95	3.248
4.02	3.501
2.99	3.841
2.50	4.025
2.00	4.220
1.50	4.467
Dec. 20, a. m.	
3.00	3.733
2.50	3.937
2.20	4.055
1.99	4.151
1.50	4.402

1929	
M.	R.
Dec. 21, a. m.	
2.99	3.906
2.51	4.068
2.20	4.177
2.00	4.254
1.50	4.468
Dec. 22, a. m.	
2.00	4.095
1.80	4.172
1.69	4.226
1.50	4.319
1.40	4.391
Dec. 23, a. m.	
2.51	3.723
2.20	3.865
1.90	3.997
1.80	4.056
1.53	4.191
Dec. 24, a. m.	
1.98	3.882
1.80	3.977
1.70	4.029
1.62	4.074
1.50	4.140
Dec. 25, a. m.	
1.15	4.352
1.10	4.383
1.07	4.404
Dec. 26, a. m.	
1.60	4.191
1.50	4.240
1.43	4.278
1.35	4.318
1.30	4.343
Dec. 27, a. m.	
1.10	4.408
1.08	4.417
1.07	4.425
1.05	4.435
1.04	4.439
Dec. 28, a. m.	
4.92	3.061
4.00	3.324
3.00	3.632
2.50	3.808
2.00	4.018
1.50	4.259
Dec. 31, a. m.	
2.00	4.094
1.80	4.176
1.69	4.219
1.60	4.258
1.50	4.299

1930	
M.	R.
Jan. 1, a. m.	
1.72	4.160
1.51	4.275
1.45	4.295
Jan. 2, a. m.	
2.00	4.001
1.80	4.106
1.70	*4.155
1.59	4.201
1.50	4.237
Jan. 3, a. m.	
1.53	3.919
1.46	4.015
1.40	4.052
Jan. 4, a. m.	
1.75	3.910
1.68	3.953
1.58	4.011
1.50	4.061
1.40	4.124
Jan. 10, a. m.	
1.05	4.418
1.03	4.425
1.02	4.427
Jan. 11, a. m.	
1.43	4.167
1.37	4.206
1.32	4.237
1.27	4.274
1.23	4.298
Jan. 12, a. m.	
1.10	4.353
1.06	4.363
1.05	4.368
1.03	4.372
Jan. 13, a. m.	
1.68	4.111
1.50	4.216
1.43	4.260
1.36	4.298
1.32	4.324
Jan. 14, a. m.	
1.70	4.087
1.60	4.148
1.52	4.197
1.45	4.237
1.40	4.268
Jan. 15, a. m.	
4.93	2.937
4.00	3.204
2.99	3.552
2.49	3.745
2.20	3.876

1930	
M.	R.
Jan. 16, a. m.	
2.79	3.523
2.50	3.653
2.30	3.747
2.13	3.828
Jan. 18, a. m.	
2.98	3.514
2.50	3.715
2.19	3.871
2.00	3.968
1.87	4.035
Jan. 23, a. m.	
1.27	4.178
1.23	4.201
1.19	4.224
1.16	4.239
1.13	4.257
Jan. 25, a. m.	
2.49	3.592
2.19	3.732
1.99	3.801
1.80	3.880
1.50	4.067
Jan. 27, a. m.	
1.17	4.302
1.14	4.315
1.12	4.325
1.09	4.339
1.08	4.344
Jan. 30, a. m.	
1.50	3.959
Jan. 31, a. m.	
1.31	4.158
1.24	4.205
1.21	4.227
1.15	4.266
1.12	4.286
Feb. 1, p. m.	
1.11	4.299
1.13	4.396
1.15	4.390
Feb. 2, a. m.	
2.20	3.735
2.00	3.846
1.79	3.958
1.64	4.036
1.56	4.083
Feb. 3, a. m.	
2.99	3.449
2.50	3.659
2.21	3.788
2.00	3.885
1.50	4.168

1930	
M.	R.
Feb. 4, a. m.	
4.98	3.042
3.97	3.307
3.00	3.626
2.49	3.808
2.00	3.990
1.50	4.212
Feb. 5, a. m.	
3.02	3.638
2.50	3.847
2.21	3.931
2.01	4.031
1.50	4.304
Feb. 6, a. m.	
3.00	3.540
2.51	3.739
2.20	3.871
2.00	3.965
1.50	4.230
Feb. 7, a. m.	
2.99	3.599
2.50	3.795
2.20	3.930
2.00	4.055
1.50	4.308
Feb. 8, a. m.	
4.99	2.944
4.00	3.244
3.00	3.575
2.51	3.757
2.00	3.981
1.50	4.214
Feb. 11, a. m.	
1.32	4.349
1.27	4.380
1.23	4.405
Feb. 12, a. m.	
1.19	4.390
1.14	4.412
1.12	4.427
1.10	4.444
Feb. 14, p. m.	
1.02	4.371
1.03	4.367
1.03	4.400
Feb. 15, a. m.	
1.02	4.256
1.02	4.306
Feb. 19, a. m.	
2.20	3.493
2.00	3.587
1.80	3.682

1930	
M.	R.
Feb. 20, a. m.	
1.18	4.064
1.15	4.093
1.12	4.119
1.10	4.135
1.08	4.156
Feb. 21, a. m.	
1.60	3.801
1.50	3.863
1.44	3.901
1.37	3.949
1.32	3.980
Feb. 22, a. m.	
1.70	3.953
1.60	4.000
1.50	4.048
1.43	4.082
1.38	4.108
Feb. 23, a. m.	
2.99	3.495
2.49	3.672
2.00	3.910
1.79	4.028
1.50	4.195
Feb. 24, a. m.	
4.90	2.798
4.00	3.072
3.00	3.445
2.50	3.650
2.00	3.866
1.50	4.113
Feb. 25, a. m.	
3.00	3.428
2.50	3.622
2.21	3.770
2.01	3.873
1.80	3.982
Feb. 26, a. m.	
2.99	3.443
2.50	3.667
2.20	3.813
2.00	3.912
1.50	4.174
Feb. 28, a. m.	
3.01	3.528
2.68	3.667
2.44	3.779
1.80	4.073
1.70	4.132
Mar. 1, a. m.	
1.90	4.129
1.79	4.178

1930	
M.	R.
Mar. 2, a. m.	
1.75	4.121
1.65	4.173
1.57	4.212
1.47	4.265
1.42	4.290
Mar. 3, a. m.	
2.15	3.793
2.01	3.853
1.88	3.907
1.60	4.062
1.50	4.126
Mar. 4, a. m.	
4.90	2.787
4.00	3.087
3.00	3.397
2.50	3.613
2.00	3.843
1.50	4.093
Mar. 5, a. m.	
3.00	3.541
2.51	3.735
2.21	3.858
2.00	3.946
1.50	4.175
Mar. 6, a. m.	
3.01	3.522
2.49	3.723
2.20	3.827
2.00	3.940
1.50	4.188
Mar. 9, a. m.	
2.00	4.024
1.80	4.094
1.70	4.130
1.60	4.167
Mar. 10, a. m.	
1.66	3.950
1.58	3.999
1.50	4.053
1.43	4.098
1.38	4.131
Mar. 12, a. m.	
4.80	3.119
4.00	3.349
2.99	3.661
2.50	3.824
2.00	4.043
1.50	4.275
Mar. 13, a. m.	
3.00	3.694
2.51	3.866
2.21	3.974
2.00	4.051
1.50	4.285

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1930	
M.	R.
Mar. 14, a. m.	
3.11	3.356
2.00	3.824
1.89	3.877
1.80	3.922
1.70	3.971
Mar. 15, a. m.	
2.93	3.488
2.50	3.659
2.21	3.761
2.00	3.856
1.50	4.093
Mar. 16, a. m.	
3.00	3.428
2.51	3.629
2.20	3.757
2.00	3.851
1.50	4.098
Mar. 17, a. m.	
4.96	3.031
3.98	3.291
3.01	3.585
2.50	3.779
2.00	3.978
1.50	4.228
Mar. 18, a. m.	
3.00	3.510
2.50	3.708
2.21	3.828
2.00	3.923
1.50	4.174
Mar. 19, a. m.	
3.00	3.415
2.51	3.609
2.20	3.736
2.00	3.809
1.50	4.056
Mar. 20, a. m.	
2.99	3.377
2.50	3.579
2.21	3.702
2.01	3.792
1.50	4.040
Mar. 21, a. m.	
2.51	3.514
2.20	3.667
2.00	3.733
1.80	3.844
1.70	3.901
Mar. 23, a. m.	
2.20	3.705
2.01	3.806
1.90	3.864
1.79	3.926
1.70	3.972

1930	
M.	R.
Mar. 24, a. m.	
4.90	3.183
3.00	3.723
2.51	3.900
2.20	4.018
2.01	4.093
1.50	4.297
Mar. 25, a. m.	
4.92	3.106
4.03	3.360
2.98	3.675
2.50	3.841
2.00	4.072
1.50	4.276
Mar. 26, a. m.	
3.00	3.619
2.51	3.801
2.20	3.920
2.01	3.996
1.50	4.245
Mar. 27, a. m.	
3.01	3.588
2.50	3.786
2.24	3.894
2.00	3.975
1.50	4.217
Mar. 28, a. m.	
2.99	3.583
2.51	3.762
2.20	3.893
2.01	3.971
1.50	4.179
Mar. 29, a. m.	
3.00	3.589
2.49	3.776
2.21	3.898
2.00	3.988
1.50	4.213
Mar. 30, a. m.	
2.99	3.592
2.50	3.775
2.00	3.971
1.80	4.050
1.50	4.174
Apr. 1, a. m.	
1.93	4.112
1.80	4.170
1.70	4.215
1.60	4.259
1.50	4.303
Apr. 2, a. m.	
4.93	3.040
4.03	3.295
3.03	3.606
2.51	3.802
2.00	3.997
1.50	4.202

1930	
M.	R.
Apr. 3, a. m.	
3.01	3.731
2.50	3.909
2.20	4.017
2.00	4.091
1.50	4.291
Apr. 4, a. m.	
2.99	3.744
2.49	3.920
2.21	4.023
2.00	4.121
1.50	4.316
Apr. 5, a. m.	
3.10	3.708
2.65	3.878
1.40	4.404
1.36	4.424
1.32	4.444
Apr. 6, a. m.	
1.99	4.079
1.89	4.121
1.73	4.176
Apr. 8, a. m.	
2.99	3.710
2.49	3.876
2.19	3.994
2.00	4.071
1.50	4.277
Apr. 9, a. m.	
5.01	3.207
4.01	3.461
3.00	3.740
2.50	3.906
2.00	4.081
1.50	4.283
Apr. 10, a. m.	
2.98	3.774
2.51	3.936
2.20	4.047
2.00	4.111
1.80	4.196
Apr. 11, a. m.	
3.00	3.758
2.50	3.910
2.20	4.025
2.01	4.100
1.80	4.182
Apr. 12, a. m.	
3.01	3.699
2.49	3.854
2.20	3.960
2.00	4.037
1.80	4.109

1930	
M.	R.
Apr. 13, a. m.	
1.18	4.256
1.17	4.255
Apr. 14, a. m.	
3.01	3.634
2.49	3.810
2.20	3.909
2.00	3.980
1.50	4.401
Apr. 15, a. m.	
1.26	4.258
1.24	4.303
Apr. 16, a. m.	
4.97	3.090
4.00	3.349
3.01	3.645
2.50	3.809
2.00	3.986
1.50	4.191
Apr. 17, a. m.	
3.00	3.550
2.71	3.640
2.50	3.712
1.75	4.013
1.66	4.044
Apr. 18, a. m.	
1.84	4.013
1.70	4.079
1.63	4.111
Apr. 19, a. m.	
2.99	3.635
2.51	3.810
2.20	3.922
2.00	3.994
1.80	4.068
Apr. 20, a. m.	
2.98	3.691
2.49	3.850
2.00	4.027
1.81	4.104
1.60	4.190
Apr. 21, a. m.	
3.00	3.957
2.49	3.771
2.21	3.870
2.00	3.944
1.50	4.161
Apr. 22, a. m.	
4.93	3.013
3.99	3.244
2.98	3.557
2.42	3.762
2.00	3.923
1.50	4.138

1930	
M.	R.
Apr. 23, a. m.	
2.70	3.607
2.20	3.783
2.00	3.848
1.90	3.882
1.80	3.915
Apr. 24, a. m.	
3.05	3.555
2.08	3.886
Apr. 25, a. m.	
1.70	3.830
1.60	3.864
1.50	3.898
1.46	3.910
1.40	3.967
Apr. 26, a. m.	
1.56	3.991
1.50	4.054
1.46	4.063
1.40	4.077
1.37	4.089
Apr. 27, a. m.	
3.01	3.696
2.50	3.845
2.01	4.009
1.80	4.085
1.50	4.198
Apr. 28, a. m.	
4.91	3.259
4.00	3.489
3.00	3.765
2.50	3.935
2.01	4.103
1.50	4.282
Apr. 29, a. m.	
2.99	3.783
2.49	3.924
2.19	4.043
2.00	4.130
1.50	4.323
Apr. 30, a. m.	
2.03	3.952
May 3, a. m.	
1.30	4.083
1.28	4.121
1.28	4.182
May 4, a. m.	
2.99	3.636
2.50	3.810
2.20	3.918
2.00	3.988
1.80	4.057

1930	
M.	R.
May 5, a. m.	
4.96	3.134
3.99	3.386
3.00	3.665
2.50	3.806
2.00	3.976
May 6, a. m.	
2.00	3.900
1.80	3.974
1.70	3.999
1.60	4.050
1.50	4.089
May 7, a. m.	
4.88	2.976
3.99	3.218
3.01	3.506
2.50	3.675
2.00	3.837
1.50	4.036
May 16, a. m.	
2.30	3.903
May 17, a. m.	
2.99	3.761
2.50	3.935
2.20	4.030
2.00	4.109
1.50	4.270
May 18, a. m.	
4.94	3.146
3.99	3.389
3.00	3.646
2.50	3.814
2.01	4.000
1.50	4.207
May 19, a. m.	
3.00	3.725
2.49	3.897
2.20	3.979
2.00	4.066
1.50	4.262
May 20, a. m.	
3.01	3.652
2.49	3.819
2.21	3.920
1.99	4.002
1.50	4.188
May 21, a. m.	
3.00	3.607
2.50	3.778
2.20	3.885
2.00	3.957
1.50	4.160

1930	
M.	R.
May 22, a. m.	
2.99	3.691
2.50	3.849
2.27	3.922
2.15	3.962
May 23, a. m.	
3.00	3.664
2.49	3.841
2.20	3.945
2.00	4.018
1.50	4.217
May 24, a. m.	
4.96	3.313
4.01	3.553
3.00	3.823
2.50	3.968
2.00	4.152
1.50	4.352
May 25, a. m.	
2.99	3.719
2.50	3.871
2.20	3.995
2.00	4.057
1.90	4.103
May 26, a. m.	
3.00	3.646
2.49	3.794
2.20	3.908
2.00	3.990
1.50	4.190
May 27, a. m.	
3.00	3.630
2.52	3.793
2.20	3.909
2.00	3.982
1.50	4.185
May 28, a. m.	
2.98	3.574
2.50	3.749
2.19	3.868
2.00	3.942
1.90	3.981
May 29, a. m.	
3.00	3.609
2.49	3.784
2.20	3.888
2.00	3.962
1.50	4.191
May 30, a. m.	
2.99	3.656
2.50	3.818
2.00	3.993
1.50	4.218

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1930	
M.	R.
May 31, a. m.	
3.00	3.710
2.50	3.873
2.19	3.969
2.00	4.047
1.50	4.243
June 1, a. m.	
2.99	3.726
2.50	3.895
2.20	3.999
2.00	4.068
1.90	4.128
June 2, a. m.	
3.01	3.666
2.50	3.844
2.00	4.037
1.90	4.079
1.50	4.244
June 3, a. m.	
4.93	3.156
4.02	3.359
2.99	3.646
2.49	3.803
2.00	3.992
1.50	4.198
June 4, a. m.	
1.72	4.029
1.66	4.051
1.61	4.082
1.56	4.103
1.52	4.122
June 5, a. m.	
2.99	3.664
2.49	3.821
2.21	3.911
2.00	3.989
1.58	4.173
June 6, a. m.	
3.00	3.607
2.50	3.750
2.20	3.876
2.00	3.965
1.90	4.010
June 7, a. m.	
4.99	3.127
4.01	3.349
2.99	3.649
2.50	3.814
2.00	3.991
1.50	4.193
June 8, a. m.	
3.00	3.716
2.50	3.886
2.20	3.988
2.00	4.064
1.80	4.142

1930	
M.	R.
June 9, a. m.	
2.86	3.642
2.50	3.779
2.20	3.897
2.00	3.973
1.90	4.028
June 13, a. m.	
2.49	3.623
2.20	3.736
2.00	3.822
1.90	3.866
1.80	3.909
June 14, a. m.	
4.96	3.155
4.00	3.372
2.99	3.642
2.50	3.815
2.00	3.998
1.50	4.210
June 15, a. m.	
3.00	3.737
2.50	3.907
2.20	4.016
2.00	4.087
1.90	4.125
June 16, a. m.	
2.98	3.897
2.49	4.056
2.20	4.153
2.00	4.222
1.50	4.395
June 17, p. m.	
1.47	4.427
1.49	4.431
1.50	4.421
June 18, a. m.	
3.00	3.869
2.50	4.079
2.20	4.129
2.00	4.201
1.90	4.237
June 19, a. m.	
4.98	3.418
4.01	3.650
3.00	3.900
2.50	4.044
2.00	4.216
1.50	4.411
June 20, a. m.	
3.01	3.881
2.49	4.036
2.20	4.124
2.00	4.188
1.50	4.366

1930	
M.	R.
June 21, a. m.	
2.99	3.839
2.50	3.982
2.00	4.153
1.52	4.364
1.50	4.374
June 22, a. m.	
2.99	3.805
2.50	3.964
2.20	4.064
2.00	4.131
1.90	4.168
June 23, a. m.	
3.00	3.751
2.50	3.918
2.20	4.036
2.00	4.094
1.50	4.256
June 24, a. m.	
4.98	3.155
4.01	3.385
3.00	3.649
2.50	3.814
2.00	3.988
1.50	4.189
June 25, a. m.	
3.00	3.692
2.51	3.850
2.20	3.965
2.00	4.037
1.90	4.075
June 26, a. m.	
3.04	3.590
2.53	3.750
2.21	3.855
2.00	3.927
1.85	3.980
June 27, a. m.	
2.99	3.541
2.51	3.736
2.20	3.861
2.00	3.960
1.86	4.013
June 28, a. m.	
4.72	3.320
3.97	3.486
3.01	3.751
2.51	3.921
2.20	4.020
2.00	4.085
1.50	4.303
June 29, a. m.	
2.98	3.819
2.51	3.943
2.20	4.060
2.00	4.139
1.90	4.168

1930	
M.	R.
June 30, a. m.	
3.01	3.826
2.51	3.971
2.20	4.063
2.00	4.123
1.50	4.297
July 1, a. m.	
3.01	3.690
2.51	3.857
2.20	3.968
2.00	4.057
1.50	4.232
July 2, a. m.	
5.02	3.135
3.98	3.363
3.01	3.640
2.50	3.794
2.00	3.968
1.50	4.154
July 3, a. m.	
1.44	4.195
1.43	4.197
1.43	4.192
July 4, a. m.	
3.00	3.663
2.50	3.820
2.20	3.918
2.01	4.005
1.90	4.030
July 5, a. m.	
3.00	3.839
2.50	3.996
2.20	4.101
2.00	4.173
1.90	4.209
July 6, a. m.	
3.00	3.868
2.50	4.032
2.20	4.132
2.00	4.203
1.90	4.237
July 7, a. m.	
1.58	4.095
1.54	4.115
1.51	4.130
July 8, a. m.	
4.97	3.169
4.00	3.390
3.01	3.656
2.50	3.830
2.00	4.009
1.50	4.213

1930	
M.	R.
July 9, a. m.	
3.00	3.624
2.50	3.776
2.20	3.884
2.00	3.962
1.95	4.000
July 10, a. m.	
3.00	3.550
2.50	3.730
2.20	3.853
2.00	3.941
1.90	3.985
July 11, a. m.	
2.99	3.730
2.50	3.887
2.20	3.986
1.99	4.057
1.90	4.090
July 12, a. m.	
4.99	3.300
4.00	3.532
3.01	3.767
2.50	3.924
2.00	4.094
1.49	4.306
July 13, a. m.	
2.94	3.829
2.49	3.993
2.33	4.054
2.11	4.119
2.00	4.150
July 14, p. m.	
1.40	4.343
July 15, a. m.	
3.06	3.813
2.82	3.897
2.62	3.949
July 17, a. m.	
2.10	4.015
1.99	4.054
1.89	4.088
July 18, a. m.	
3.00	3.735
2.50	3.889
2.20	3.987
2.00	4.065
1.90	4.107
July 19, a. m.	
2.99	3.650
2.49	3.814
2.20	3.939
2.00	4.011
1.50	4.179

1930	
M.	R.
July 20, a. m.	
3.00	3.672
2.50	3.837
2.20	3.941
2.00	4.011
1.90	4.046
July 21, a. m.	
2.98	3.657
2.49	3.811
2.20	3.900
2.00	3.972
1.83	4.047
July 22, a. m.	
1.47	4.142
1.45	4.145
1.42	4.170
1.40	4.173
July 23, a. m.	
2.50	3.698
2.20	3.880
2.00	3.961
1.90	4.000
July 24, a. m.	
2.99	3.731
2.49	3.886
2.20	3.986
2.00	4.057
1.90	4.093
July 25, a. m.	
2.99	3.806
2.50	3.946
2.20	4.049
2.00	4.121
1.89	4.160
July 26, a. m.	
3.01	3.737
2.50	3.892
2.20	3.994
2.00	4.075
1.89	4.121
July 27, a. m.	
2.99	3.619
2.50	3.777
2.20	3.884
2.00	3.984
1.90	4.025
July 28, a. m.	
3.00	3.621
2.49	3.786
2.20	3.897
2.00	3.976
1.50	4.184

1930	
M.	R.
July 29, a. m.	
2.95	3.693
2.50	3.847
2.19	3.951
2.00	4.027
1.90	4.060
July 30, a. m.	
2.50	3.831
2.32	3.897
2.19	3.935
1.99	4.018
1.89	4.055
July 31, a. m.	
4.92	3.185
3.98	3.415
2.99	3.676
2.50	3.845
2.00	4.026
1.50	4.216
Aug. 1, a. m.	
3.00	3.593
2.50	3.743
2.20	3.856
2.00	3.942
1.50	4.164
Aug. 2, a. m.	
2.98	3.658
2.49	3.855
2.20	3.924
2.00	4.001
1.50	4.222
Aug. 3, a. m.	
2.99	3.499
2.49	3.676
2.20	3.783
2.00	3.874
1.40	3.918
Aug. 4, a. m.	
2.41	3.724
2.27	3.780
1.90	3.940
1.74	4.012
1.67	4.045
Aug. 9, a. m.	
3.01	3.551
2.74	3.622
2.20	3.819
2.01	3.891
Aug. 10, a. m.	
3.02	3.718
2.71	3.810
2.50	3.875
2.20	3.981
2.00	4.053

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1930	
M.	R.
Aug. 11, a. m.	
4.93	3.378
3.96	3.595
2.99	3.865
2.50	4.010
2.00	4.161
1.50	4.330
Aug. 14, a. m.	
2.99	3.296
2.64	3.359
Aug. 15, a. m.	
3.00	3.565
2.50	3.744
2.19	3.841
2.00	3.913
1.80	3.990
Aug. 16, a. m.	
4.90	3.162
4.00	3.366
3.00	3.645
2.50	3.794
2.19	3.903
2.00	3.972
Aug. 17, a. m.	
2.82	3.730
2.50	3.829
2.20	3.928
1.99	4.018
1.80	4.081
Aug. 20, a. m.	
1.34	4.298
1.37	4.291
1.40	4.279
Aug. 21, a. m.	
4.95	3.366
4.01	3.583
3.00	3.854
2.49	4.006
1.99	4.184
1.49	4.375
Aug. 22, a. m.	
2.93	3.835
2.49	3.966
2.21	4.066
2.00	4.143
1.51	4.335
Aug. 23, a. m.	
3.02	3.830
2.51	3.989
2.20	4.109
2.00	4.188
1.40	4.409

1930	
M.	R.
Aug. 25, a. m.	
3.02	3.757
2.51	3.927
2.20	4.039
2.01	4.126
1.50	4.314
Aug. 26, a. m.	
4.96	3.340
3.96	3.575
3.01	3.819
2.50	3.994
2.00	4.167
1.50	4.373
Aug. 27, a. m.	
3.01	3.653
2.50	3.821
2.19	3.907
2.00	3.996
1.60	4.141
Aug. 28, a. m.	
2.50	3.759
2.20	3.848
2.00	3.936
Aug. 29, a. m.	
2.98	3.679
2.50	3.830
2.20	3.928
2.01	3.992
1.50	4.200
Aug. 30, a. m.	
3.00	3.645
2.49	3.792
2.20	3.880
2.00	3.948
1.50	4.164
Aug. 31, a. m.	
4.89	3.200
4.00	3.429
3.00	3.708
2.50	3.862
2.00	4.032
1.50	4.250
Sept. 1, a. m.	
3.00	3.716
2.50	3.876
2.21	3.972
2.00	4.042
1.50	4.233
Sept. 2, a. m.	
3.00	3.712
2.50	3.874
2.21	3.971
1.99	4.056
1.50	4.234

1930	
M.	R.
Sept. 3, a. m.	
3.00	3.712
2.50	3.874
2.21	3.971
1.99	4.056
1.50	4.234
Sept. 4, a. m.	
2.99	3.733
2.49	3.917
2.20	3.999
2.00	4.087
1.50	4.267
Sept. 5, a. m.	
4.95	3.279
3.99	3.499
2.99	3.802
2.49	3.950
2.00	4.130
1.50	4.314
Sept. 6, a. m.	
2.98	3.768
2.49	3.929
2.21	4.025
1.99	4.105
1.50	4.302
Sept. 7, a. m.	
2.98	3.616
2.50	3.812
2.20	3.919
2.00	3.993
1.50	4.223
Sept. 8, a. m.	
2.98	3.727
2.50	3.889
2.20	4.012
2.00	4.096
1.50	4.314
Sept. 9, a. m.	
3.00	3.555
2.50	3.760
2.20	3.864
2.00	3.934
1.50	4.180
Sept. 10, a. m.	
4.93	2.985
3.97	3.251
3.00	3.554
2.49	3.743
2.00	3.935
1.50	4.176
Sept. 11, p. m.	
1.74	3.998
1.83	3.959
1.94	3.909

1930	
M.	R.
Sept. 12, a. m.	
2.00	3.857
1.80	3.946
1.70	3.981
1.60	4.034
1.50	4.082
Sept. 13, a. m.	
2.24	3.717
2.08	3.787
1.90	3.828
Sept. 14, a. m.	
3.01	3.391
2.43	3.599
2.23	3.678
1.90	3.839
1.72	3.910
Sept. 16, a. m.	
3.00	3.492
2.50	3.666
2.19	3.812
2.00	3.891
1.50	4.101
Sept. 17, a. m.	
1.15	4.421
1.14	4.451
1.13	4.467
Sept. 19, a. m.	
1.20	4.084
1.18	4.094
1.16	4.102
Sept. 24, a. m.	
1.10	4.405
1.11	4.402
1.13	4.340
Sept. 25, a. m.	
3.01	3.784
2.49	3.952
2.20	4.048
2.00	4.113
1.50	4.327
Sept. 26, a. m.	
4.93	3.111
4.02	3.343
3.01	3.639
2.51	3.814
2.00	4.003
1.50	4.207
Sept. 27, a. m.	
1.25	4.257
1.21	4.259

1930	
M.	R.
Sept. 29, a. m.	
3.00	3.590
2.51	3.767
2.20	3.882
2.00	3.956
1.50	4.197
Sept. 30, a. m.	
3.00	3.394
2.51	3.599
2.20	3.735
2.00	3.826
1.50	4.109
Oct. 1, a. m.	
4.92	3.152
4.00	3.389
3.00	3.683
2.50	3.873
2.00	4.073
1.49	4.294
Oct. 2, a. m.	
3.00	3.808
2.51	3.975
2.19	4.086
2.00	4.156
1.50	4.373
Oct. 3, a. m.	
3.00	3.877
2.51	4.036
2.19	4.152
2.00	4.229
1.50	4.444
Oct. 4, a. m.	
3.01	3.888
2.49	4.066
2.19	4.177
2.00	4.246
1.50	4.453
Oct. 5, a. m.	
2.98	3.779
2.49	3.928
2.19	4.048
2.00	4.126
1.50	4.316
Oct. 6, a. m.	
3.01	3.757
2.49	3.936
2.19	4.034
2.00	4.112
1.50	4.350
Oct. 8, a. m.	
2.49	3.819
2.20	3.930
2.00	4.010
1.80	4.092
1.50	4.215

1930	
M.	R.
Oct. 9, a. m.	
4.95	3.207
3.97	3.456
3.01	3.739
2.49	3.907
2.00	4.094
1.50	4.324
Oct. 10, a. m.	
3.01	3.664
2.49	3.843
2.20	3.959
2.00	4.047
1.50	4.275
Oct. 11, a. m.	
2.99	3.807
2.49	3.964
2.20	4.072
2.00	4.145
1.50	4.339
Oct. 12, a. m.	
1.08	4.462
1.07	4.473
1.06	4.531
Oct. 13, a. m.	
3.00	3.412
2.50	3.623
2.20	3.770
2.00	3.873
1.50	4.098
Oct. 14, a. m.	
4.90	2.923
4.00	3.199
3.00	3.549
2.50	3.742
2.00	3.953
1.50	4.155
Oct. 15, a. m.	
3.00	3.759
2.70	3.864
2.46	3.948
1.87	4.167
Oct. 16, a. m.	
3.02	3.818
2.49	3.994
1.98	4.187
1.70	4.303
1.50	4.395
Oct. 17, a. m.	
3.06	3.778
2.12	4.100
1.86	4.206
1.62	4.305

1930	
M.	R.
Oct. 20, a. m.	
2.99	3.476
2.49	3.688
2.00	3.904
1.68	4.076
1.50	4.179
Oct. 22, a. m.	
2.99	3.642
1.62	4.188
1.54	4.227
1.44	4.277
1.38	4.306
Oct. 23, a. m.	
4.90	3.290
4.00	3.516
3.00	3.798
2.51	3.987
2.00	4.169
1.50	4.366
Oct. 24, a. m.	
3.01	3.758
2.49	3.942
2.20	4.047
2.00	4.111
1.50	4.334
Oct. 25, a. m.	
2.99	3.836
2.50	4.018
2.20	4.132
2.00	4.212
1.50	4.421
Oct. 26, a. m.	
1.90	4.206
1.80	4.252
1.70	4.297
Oct. 27, a. m.	
1.47	4.372
1.41	4.415
1.36	4.440
1.30	4.445
1.26	4.465
Oct. 28, a. m.	
1.90	4.187
1.79	4.236
1.70	4.278
1.60	4.320
1.50	4.358
Oct. 29, a. m.	
2.49	4.036
2.20	4.123
1.70	4.323
1.60	4.372
1.50	4.421

TABLE 27.—*Pyrheliometer readings, Montezuma, Chile, 1926–1930*—Continued

[Pyrheliometer S. I. No. 30 and S. I. No. 29 reduced to the scale of No. 30. To reduce to gram-calories per minute per cm², multiply R by 0.3629]

1930	
M.	R.
Oct. 30, a. m.	
4.93	3.405
4.02	3.632
3.02	3.908
2.50	4.076
2.00	4.245
1.50	4.445
Oct. 31, a. m.	
3.00	3.857
2.51	4.034
2.19	4.132
2.00	4.221
1.50	4.446
Nov. 1, a. m.	
3.01	3.792
2.50	3.971
2.20	4.079
2.00	4.166
1.50	4.387
Nov. 3, a. m.	
1.83	3.953
Nov. 4, a. m.	
2.78	3.671
Nov. 5, a. m.	
1.10	4.530
1.09	4.537
Nov. 6, a. m.	
1.79	4.225
1.35	4.436
1.30	4.461
1.26	4.479
1.22	4.500
Nov. 7, a. m.	
3.02	3.856
2.50	4.037
2.20	4.148
2.00	4.237
1.50	4.446
Nov. 8, a. m.	
1.01	4.502
1.01	4.534
1.01	4.507

1930	
M.	R.
Nov. 9, a. m.	
4.92	3.335
4.03	3.565
3.02	3.867
2.51	4.026
2.00	4.234
1.50	4.447
Nov. 10, a. m.	
3.01	3.756
2.50	3.937
2.20	4.049
2.00	4.128
1.50	4.338
Nov. 11, a. m.	
3.07	3.659
2.76	3.784
2.49	3.878
2.07	4.033
Nov. 12, a. m.	
2.51	3.584
2.19	3.725
1.59	4.021
Nov. 13, a. m.	
2.50	3.885
2.21	4.018
2.01	4.112
1.80	4.205
1.50	4.365
Nov. 14, a. m.	
4.93	3.079
3.97	3.342
3.00	3.640
2.49	3.841
2.00	4.045
1.50	4.265
Nov. 15, a. m.	
3.00	3.852
2.49	4.031
2.20	4.160
2.00	4.212
1.50	4.434

1930	
M.	R.
Nov. 17, a. m.	
3.01	3.783
2.50	3.956
2.19	4.058
2.00	4.142
1.50	4.376
Nov. 18, a. m.	
3.01	3.825
2.49	4.000
2.20	4.109
1.99	4.203
1.50	4.405
Nov. 19, a. m.	
4.92	3.329
3.97	3.543
3.00	3.837
2.50	4.002
2.01	4.174
1.50	4.402
Nov. 20, a. m.	
3.00	3.836
2.49	4.031
2.20	4.147
2.01	4.217
1.50	4.439
Nov. 21, a. m.	
1.90	4.243
1.79	4.310
1.69	4.346
1.60	4.376
1.50	4.415
Nov. 22, a. m.	
1.18	4.585
Nov. 26, a. m.	
4.93	2.987
3.99	3.243
3.02	3.588
2.51	3.768
2.00	3.969
1.50	4.250
Nov. 27, a. m.	
3.02	3.742
2.49	3.930
2.00	4.128
1.70	4.250
1.50	4.326

1930	
M.	R.
Nov. 28, a. m.	
3.02	3.759
2.51	3.941
2.00	4.149
1.70	4.276
1.50	4.371
Nov. 29, a. m.	
3.02	3.401
2.49	3.641
2.01	3.902
1.70	4.091
1.50	4.209
Nov. 30, a. m.	
4.94	3.261
4.01	3.503
3.00	3.794
2.49	3.982
2.00	4.171
1.50	4.413
Dec. 1, a. m.	
3.00	3.812
2.50	3.973
2.21	4.084
2.00	4.168
1.50	4.405
Dec. 2, a. m.	
3.00	3.785
2.50	3.960
2.21	4.072
2.00	4.154
1.50	4.358
Dec. 3, a. m.	
3.01	3.771
2.50	3.956
2.20	4.079
2.00	4.157
1.50	4.386
Dec. 4, a. m.	
3.02	3.599
2.51	3.806
2.20	3.938
2.00	4.026
1.50	4.276

1930	
M.	R.
Dec. 5, a. m.	
4.99	3.275
3.98	3.526
2.99	3.831
2.49	4.006
2.00	4.181
1.50	4.414
Dec. 6, a. m.	
3.00	3.799
2.50	3.971
2.21	4.096
2.00	4.188
1.50	4.417
Dec. 7, a. m.	
3.00	3.921
2.50	4.084
2.20	4.208
2.00	4.293
1.50	4.511
Dec. 8, a. m.	
3.01	3.875
2.51	4.021
2.20	4.148
1.99	4.223
1.50	4.424
Dec. 9, a. m.	
2.99	3.867
2.53	4.008
1.70	4.339
1.62	4.374
Dec. 10, a. m.	
1.06	4.664
1.05	4.673
1.04	4.678
Dec. 11, a. m.	
1.90	4.248
1.79	4.289
1.70	4.324
1.60	4.364
1.50	4.403

1930	
M.	R.
Dec. 12, a. m.	
4.96	3.289
4.01	3.530
3.02	3.859
2.49	4.048
2.00	4.237
1.50	4.476
Dec. 13, a. m.	
2.99	3.898
2.49	4.081
2.19	4.193
2.00	4.267
1.50	4.496
Dec. 14, a. m.	
3.00	3.916
2.50	4.092
2.20	4.198
2.00	4.269
1.50	4.480
Dec. 15, a. m.	
3.01	3.861
2.49	4.046
2.20	4.136
2.00	4.200
1.50	4.420
Dec. 16, a. m.	
2.99	3.797
2.50	3.968
2.19	4.082
2.00	4.152
1.50	4.401
Dec. 17, a. m.	
4.93	3.320
4.00	3.572
3.00	3.868
2.49	4.066
1.99	4.272
1.50	4.485
Dec. 18, a. m.	
2.99	3.881
2.49	4.054
2.21	4.169
2.00	4.258
1.50	4.478

1930	
M.	R.
Dec. 19, a. m.	
1.61	4.394
1.54	4.425
1.47	4.458
1.40	4.488
1.35	4.511
Dec. 20, a. m.	
1.50	4.476
1.43	4.530
1.38	4.573
1.33	4.610
1.28	4.642
Dec. 21, a. m.	
1.10	4.582
1.08	4.594
1.06	4.605
Dec. 22, a. m.	
1.60	4.370
1.53	4.398
1.34	4.477
Dec. 23, a. m.	
1.00	4.640
1.00	4.672
Dec. 24, a. m.	
3.01	3.760
2.49	3.946
2.20	4.055
2.00	4.141
1.50	4.380
Dec. 25. a. m.	
2.93	3.710
2.65	3.820
2.43	3.915
2.25	3.992
Dec. 26, a.m.	
3.01	3.616
2.49	3.810
2.20	3.919
2.00	3.997
1.50	4.241

Chapter V

BOLOMETRY

The tables of solar-constant values which follow are given in two forms. Where the Langley method has been followed, the tables are similar to those in Volume IV of these Annals. Where a short method is employed, the data as to atmospheric transmission are omitted, since they are not directly observed. Days in which the Langley method was employed will be found duplicated in the short-method tables, and usually with three short-method determinations.

For clearness we quote with certain changes from pages 129 and 130 of volume IV of these Annals the description appropriate to the Langley-method tables. The short-method tables which follow those by Langley's method will require no further description than has already been given.

DETERMINATIONS OF THE SOLAR CONSTANT OF RADIATION BY THE METHOD OF HIGH AND LOW SUN OBSERVATIONS OF HOMOGENEOUS RAYS AND THE ATMOSPHERIC TRANSMISSION FOR DIFFERENT WAVE LENGTHS

We give now in condensed form the result of independent determinations of the solar constant of radiation by the spectrobolometric method. They were obtained in part at Montezuma, Chile, at latitude 22° 40′ S., longitude 68° 56′ W., elevation 2,711 meters; in part at Mount Harqua Hala, Ariz., latitude 33° 48′ N., longitude 113° 20′ W., altitude 1,721 meters; in part at Table Mountain, Calif., latitude 34° 22′ N., longitude 117° 41′ W., altitude 2,286 meters; and in part at Mount Brukkaros, Southwest Africa, latitude 25° 52′ S., longitude 17° 48′ E., altitude 1,586 meters.[1] Some of the solar-constant results were reached by the complex process of combining spectrum measurements by the bolometer with pyrheliometric observations after the manner described in Volumes II and III of these Annals. Most of the values have been obtained by the shorter method, depending upon observations of the brightness of the sky with the pyranometer in combination with the measurements of the spectrobolometer and pyrheliometer as described in Chapter II of the present volume. Whether obtained by the older process or the new, the solar-constant values are believed to represent closely the actual intensity of the solar radiation as it is in space at the earth's mean distance from the sun, and not to be much affected by absorption or scattering within the earth's atmosphere. All of the determinations of radiation are expressed in calories per square centimeter per minute according to the scale of Smithsonian Revised Pyrheliometry of 1913.

The following tables, nearly uniform [2] with those which appeared on pages 104 to 112 of Volume III of the Annals [and on pages 131 to 158 of Volume IV], give the results obtained by the long method at the several stations for the years 1920 to 1930. Column 1 gives the date; column 2, the pressure of aqueous vapor prevailing during the observations expressed in millimeters of mercury. Column 3, "precipitable water," gives the depth of liquid water which

[1] This station was founded and supported by the National Geographic Society 1926 to 1929, and thereafter supported by Mr. J. A. Roebling.

[2] Certain data as to pyrheliometry formerly given are here omitted.

would be produced by condensing all the water vapor in the atmosphere vertically above the observer. Column 4 gives the intensity of solar radiation at the station at air mass 2.0 reduced to mean solar distance.

Columns 5 to 17 give the results of spectrobolometric work and of this combined with pyrheliometry. The principal result of the whole table is E'_0 given in column 16, which expresses the intensity of solar radiation outside the atmosphere at the earth's mean distance from the sun. It is found by combining pyrheliometry and bolometry according to the method of Langley, as explained in Chapter I in Volume III of these Annals, but with a correction applied to the preliminary result (E_0, found in column 15) in order to allow for the residual effect of water vapor discussed in Chapter III of the Annals, Volume III. Column 17 gives the grade of the determination of the solar constant. It depends mainly on the approximation of the logarithmic transmission plots to straight lines. Columns 5 to 14 give the coefficients of atmospheric transmission for different wave lengths. They indicate the fraction of the light of a given wave length which would be transmitted from a celestial body in the zenith to the observing station.

In Table 29*a*, long-method Harqua Hala values, we give monthly means. Monthly mean values for other stations will be found in Chapter VI, in connection with discussions involving them.

TABLE 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.349 μ	38 0.395 μ	32 0.450 μ	28 0.499 μ	22 0.621 μ	19 0.714 μ	17 0.803 μ	14 0.977 μ	11 1.214 μ	6 1.593 μ			
1920	*Mm*	*Mm*														
Aug. 3	1.0	2.6	1.500	------	------	------	------	------	------	------	------	------	------	1.919	1.917	v.g.+
4	1.1	1.0	1.555	------	------	------	------	------	------	------	------	------	------	1.922	1.920	v.g.−
5	0.6	1.6	1.528	------	------	------	------	------	------	------	------	------	------	1.927	1.925	v.g.−
7	1.2	3.7	1.540	------	------	------	------	------	------	------	------	------	------	1.932	1.932	e.−
12	1.8	3.8	1.468	------	------	------	------	------	------	------	------	------	------	1.932	1.932	e.
13	2.1	(2.0)	1.504	------	------	------	------	------	------	------	------	------	------	1.979	1.977	e.
17	2.3	(4.0)	1.466	------	------	------	------	------	------	------	------	------	------	1.968	1.968	e.
20	2.6	5.1	1.456	------	------	------	------	------	------	------	------	------	------	1.924	1.924	v.g.+
21	2.1	2.2	1.503	------	------	------	------	------	------	------	------	------	------	1.940	1.938	e.−
23	0.6	0.7	1.557	------	------	------	------	------	------	------	------	------	------	1.942	1.942	e.+
27	1.3	2.9	1.496	------	------	------	------	------	------	------	------	------	------	1.928	1.926	e.
28	1.3	2.2	1.515	------	------	------	------	------	------	------	------	------	------	1.951	1.949	e.
29	2.4	4.6	1.450	------	------	------	------	------	------	------	------	------	------	1.915	1.915	c.−
30	2.5	4.1	1.456	------	------	------	------	------	------	------	------	------	------	1.921	1.921	e.−
31	1.9	3.0	1.506	------	------	------	------	------	------	------	------	------	------	1.923	1.923	e.−
Sept. 1	1.2	2.2	1.500	0.642	0.745	0.840	0.873	0.919	0.951	0.966	0.978	0.978	0.984	1.939	1.937	e.
2	0.8	1.0	1.566	.655	.765	.855	.886	.926	.966	.976	.983	.980	.987	1.956	1.953	v.g.+
6	2.4	4.1	1.515	.657	.747	.834	.871	.917	.960	.974	.981	.976	.983	1.978	1.978	v.g.−
7	1.6	1.9	1.524	.668	.760	.850	.880	.923	.960	.973	.982	.980	.988	1.951	1.949	v.g.+
8	1.3	2.0	1.552	.648	.762	.853	.881	.924	.969	.976	.982	.981	.987	1.964	1.962	v.g.
9	1.5	2.3	1.525	------	------	------	------	------	------	------	------	------	------	1.918	1.916	e.
10	1.2	1.5	1.553	.655	.761	.850	.885	.925	.960	.976	.982	.984	.990	1.953	1.951	v.g.+
12	1.8	2.6	1.510	.651	.741	.830	.876	.919	.957	.973	.978	.983	.981	1.943	1.941	e.−
13	1.9	5.5	1.484	------	------	------	------	------	------	------	------	------	------	1.916	1.916	v.g.+
14	2.5	4.6	1.493	.665	.753	.841	.877	.920	.961	.973	.980	.982	.982	1.945	1.945	e.−
16	1.8	2.2	1.514	------	------	------	------	------	------	------	------	------	------	1.937	1.935	v.g.+
17	1.8	1.8	1.533	.641	.762	.850	.885	.923	.963	.976	.983	.982	.985	1.951	1.949	e.
18	1.8	1.7	1.534	.654	.762	.850	.883	.925	.966	.976	.984	.984	.990	1.948	1.946	e.−
23	2.5	2.1	------	------	------	------	------	------	------	------	------	------	------	1.961	1.959	v.g.
24	1.0	1.4	1.543	.648	.757	.850	.882	.922	.960	.974	.985	.985	.985	1.946	1.944	e.−
25	1.1	1.4	1.553	.652	.752	.843	.881	.923	.970	.980	.987	.987	.990	1.941	1.939	v.g.+
27	2.0	5.3	------	------	------	------	------	------	------	------	------	------	------	1.914	1.915	g.
28	2.7	5.9	1.475	------	------	------	------	------	------	------	------	------	------	1.952	1.953	e.−

Table 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.349 μ	38 0.395 μ	32 0.450 μ	28 0.499 μ	22 0.621 μ	19 0.714 μ	17 0.803 μ	14 0.977 μ	11 1.214 μ	6 1.593 μ			
1920	*Mm*	*Mm*														
Oct. 1	3.0	4.0	1.497	------	------	------	------	------	------	------	------	------	------	1.938	1.938	v.g.+
2	2.3	3.3	1.473	------	------	------	------	------	------	------	------	------	------	1.912	1.912	v.g.+
4	1.5	1.7	1.536	------	------	------	------	------	------	------	------	------	------	1.946	1.944	e.
5	1.4	1.6	1.547	0.665	0.765	0.853	0.887	0.932	0.969	0.979	0.982	0.984	0.989	1.951	1.949	e.
6	1.8	2.3	1.503	------	------	------	------	------	------	------	------	------	------	1.937	1.935	v.g.
11	1.3	2.9	1.499	.653	.777	.851	.875	.927	.963	.973	.981	.981	.982	1.948	1.946	e.
15	2.7	4.6	1.446	------	------	------	------	------	------	------	------	------	------	1.969	1.969	v.g.+
16	1.9	3.6	1.470	.644	.753	.840	.868	.915	.953	.961	.973	.972	.974	1.952	1.952	e.
21	2.8	3.6	1.484	.684	.765	.845	.880	.927	.954	.967	.972	.972	.976	1.954	1.954	e.−
29	1.6	6.4	1.421	.617	.698	.797	.859	.899	.945	.971	.988	.995	.995	1.948	1.949	v.g.
Nov. 1	3.6	5.4	1.448	.625	.732	.832	.864	.906	.947	.969	.975	.974	.979	1.963	1.963	v.g.+
5	1.7	2.3	1.507	------	------	------	------	------	------	------	------	------	------	1.974	1.972	v.g.+
13	2.3	2.4	1.493	.637	.750	.842	.872	.917	.957	.971	.977	.979	.982	1.950	1.948	e.+
15	2.4	4.3	1.431	.642	.732	.815	.853	.902	.935	.950	.960	.963	.965	1.964	1.964	e.−
Dec. 5	4.4	5.9	1.460	------	------	------	------	------	------	------	------	------	------	1.936	1.937	v.g.+
8	3.8	5.8	------	.646	.749	.842	.881	.918	.958	.975	.981	.981	.989	1.949	1.950	v.g.
11	3.6	5.9	1.465	.640	.742	.825	.870	.909	.954	.969	.986	.979	.982	1.984	1.985	e.−
15	2.1	2.0	1.501	------	------	------	------	------	------	------	------	------	------	1.971	1.969	v.g.+
1921																
Jan. 18	5.7	10.1	1.370	------	------	------	------	------	------	------	------	------	------	1.932	1.934	v.g.+
June 9	0.4	0.5	1.576	------	------	------	------	------	------	------	------	------	------	1.967	1.964	v.g.
Sept. 24	2.1	3.4	------	------	------	------	------	------	------	------	------	------	------	1.937	1.937	v.g.−
25	2.7	5.0	1.489	------	------	------	------	------	------	------	------	------	------	1.963	1.963	v.g.+
27	1.0	2.8	1.511	------	------	------	------	------	------	------	------	------	------	1.970	1.968	v.g.+
28	3.2	3.0	1.539	------	------	------	------	------	------	------	------	------	------	1.972	1.971	e.−
30	1.0	2.6	1.558	.634	.755	.845	.885	.922	.966	.974	.980	.976	.985	1.957	1.955	v.g.+
Oct. 3	0.9	4.9	------	.652	.754	.835	.867	.912	.955	.981	.984	.982	.989	1.933	1.933	v.g.
4	1.7	4.7	1.502	.652	.742	.839	.875	.916	.962	.974	.977	.985	.977	1.966	1.966	e.
5	2.1	3.5	1.497	.653	.763	.843	.876	.916	.965	.974	.982	.987	.990	1.939	1.939	e.
6	1.6	4.4	1.453	------	------	------	------	------	------	------	------	------	------	1.983	1.983	v.g.+
7	1.5	(4.0)	1.499	------	------	------	------	------	------	------	------	------	------	1.967	1.967	e.−
8	1.9	4.2	1.441	.656	.753	.840	.872	.913	.953	.965	.978	.976	.977	1.937	1.937	v.g.
9	1.6	6.5	1.439	.667	.744	.838	.864	.912	.956	.979	.982	.985	.984	1.931	1.932	v.g.+
22	1.7	3.2	------	------	------	------	------	------	------	------	------	------	------	1.938	1.938	v.g.
23	1.6	4.4	1.489	------	------	------	------	------	------	------	------	------	------	1.975	1.975	e.
Nov. 17	1.7	(3.8)	1.497	.646	.752	.840	.881	.923	.965	.974	.986	.990	.986	1.950	1.950	e.
18	2.5	3.0	1.505	.620	.745	.843	.882	.916	.972	.983	.989	.994	.989	1.936	1.935	e.
21	2.8	(2.9)	1.495	.630	.740	.851	.873	.925	.956	.970	.984	.982	.983	1.950	1.949	e.
23	1.9	(1.3)	1.524	------	------	------	------	------	------	------	------	------	------	1.900	1.897	v.g.+
25	1.7	(1.3)	1.530	.620	.739	.843	.867	.914	.960	.973	.983	.985	.989	1.954	1.951	e.
26	2.4	(4.5)	1.477	------	------	------	------	------	------	------	------	------	------	1.948	1.948	e.+
Dec. 2	4.0	5.4	1.477	.612	.742	.831	.878	.914	.955	.970	.980	.983	.984	1.952	1.952	e.+
9	2.3	2.9	1.490	------	------	------	------	------	------	------	------	------	------	1.975	1.974	e.
1922																
Jan. 21	1.8	3.3	------	.638	.747	.825	.867	.907	.950	.968	.975	.979	.980	1.959	1.959	e.
22	2.7	(9.1)	1.290	------	------	------	------	------	------	------	------	------	------	1.941	1.943	e.+
24	3.8	10.0	1.400	.606	.730	.801	.860	.903	.940	.957	.975	.973	.980	1.957	1.959	e.
25	4.6	11.5	------	.610	.730	.810	.851	.902	.925	.954	.959	.963	.958	1.927	1.929	e.
26	4.6	10.9	1.396	.631	.723	.822	.863	.903	.944	.967	.977	.975	.978	1.936	1.938	e.+
27	4.6	(7.0)	1.382	.610	.717	.823	.849	.899	.939	.964	.970	.975	.967	1.944	1.945	e.
28	5.1	(9.0)	------	.637	.737	.824	.862	.905	.947	.965	.975	.979	.978	1.951	1.953	e.
30	4.2	(7.0)	------	------	------	------	------	------	------	------	------	------	------	1.987	1.989	e.+
31	5.4	8.6	1.404	.630	.737	.824	.855	.905	.937	.958	.966	.968	.975	1.959	1.961	e.+
Feb. 10	3.8	9.0	------	------	------	------	------	------	------	------	------	------	------	1.910	1.912	v.g.
12	4.2	3.0	------	------	------	------	------	------	------	------	------	------	------	1.977	1.976	v.g.
13	3.8	5.5	1.456	.585	.738	.832	.877	.927	.955	.963	.969	.960	.977	1.938	1.938	v.g.+
15	4.1	15.8	1.322	.564	.693	.790	.831	.879	.908	.944	.957	.954	.959	1.967	1.967	v.g.+
18	4.8	13.6	------	------	------	------	------	------	------	------	------	------	------	1.996	1.997	v.g.
19	6.2	13.6	------	.597	.653	.788	.836	.888	.922	.939	.951	.952	.949	1.932	1.934	v.g.
22	5.2	14.8	1.358	.590	.730	.800	.847	.880	.928	.950	.966	.964	.975	1.958	1.959	v.g.
23	4.8	10.3	------	.624	.741	.830	.867	.908	.938	.946	.967	.965	.952	1.930	1.932	e.
24	5.3	8.4	------	------	------	------	------	------	------	------	------	------	------	1.969	1.971	v.g.
25	6.3	11.9	------	.595	.695	.792	.862	.909	.929	.949	.964	.961	.946	1.936	1.938	v.g.
28	6.3	11.4	1.361	.612	.722	.821	.852	.895	.928	.950	.965	.967	.962	1.940	1.942	e.−

Table 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46, 0.349 μ	38, 0.395 μ	32, 0.450 μ	28, 0.499 μ	22, 0.621 μ	19, 0.714 μ	17, 0.803 μ	14, 0.977 μ	11, 1.214 μ	6, 1.593 μ	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1922	*Mm*	*Mm*														
Mar. 3	3.3	7.2	1.425	0.621	0.737	0.832	0.870	0.911	0.946	0.971	0.979	0.978	0.981	1.932	1.933	e.
7	3.1	4.0	1.480	.645	.755	.847	.877	.915	.953	.970	.977	.978	.984	1.965	1.965	e.+
11	1.8	2.1	1.515	.638	.755	.841	.883	.925	.961	.977	.987	.984	.990	1.963	1.961	e.
12	2.5	2.0	1.518	.638	.757	.852	.880	.925	.959	.975	.982	.982	.986	1.947	1.945	e.
13	2.3	3.1	1.484	------	------	------	------	------	------	------	------	------	------	1.908	1.908	v.g.
23	2.9	6.0	1.448	------	------	------	------	------	------	------	------	------	------	1.957	1.958	e.−
Apr. 7	2.6	3.0	1.478	.663	.754	.827	.867	.908	.966	.967	.978	.962	.974	1.958	1.957	v.g.
May 10	1.6	1.9	1.532	.638	.757	.848	.880	.923	.968	.981	.988	.986	.991	1.958	1.956	e.
June 15	0.7	0.7	1.565	------	------	------	------	------	------	------	------	------	------	1.934	1.931	e.
Aug. 12	0.9	1.5	1.525	------	------	------	------	------	------	------	------	------	------	1.974	1.976	v.g.+
Oct. 6	3.3	3.7	1.510	------	------	------	------	------	------	------	------	------	------	1.913	1.913	e.
12	2.8	2.6	1.495	------	------	------	------	------	------	------	------	------	------	1.956	1.954	e.
Nov. 6	2.5	5.4	1.451	------	------	------	------	------	------	------	------	------	------	1.920	1.920	v.g.
1923																
Jan. 4	4.2	9.5	1.405	.629	.728	.806	.860	.901	.943	.965	.978	.975	.978	1.961	1.963	v.g.
30	4.9	18.2	1.322	.562	.699	.772	.830	.882	.925	.943	.963	.967	.962	1.973	1.973	v.g.+
Feb. 2	7.2	10.5	1.379	.630	.707	.786	.837	.883	.932	.949	.965	.966	.966	1.987	1.989	e.
3	6.6	9.4	------	.602	.721	.814	.859	.900	.939	.953	.960	.962	.967	1.979	1.981	v.g.
24	6.7	14.2	1.395	.640	.736	.812	.862	.897	.941	.958	.966	.967	.961	1.989	1.990	g.+
27	7.3	13.9	1,361	.605	.725	.806	.836	.884	.928	.947	.957	.954	.960	1.988	1.989	v.g.
Mar. 5	5.8	6.7	1.422	.628	.741	.829	.859	.909	.956	.968	.974	.980	.979	1.955	1.956	v.g.
6	4.8	11.4	1.389	.606	.712	.798	.842	.902	.936	.951	.961	.972	.956	1.994	1.996	v.g.
7	5.7	6.6	1.446	.613	.723	.811	.870	.908	.949	.966	.978	.977	.976	1.998	1.999	v.g.+
8	4.6	1.8	1.508	.640	.745	.824	.886	.921	.967	.981	.987	.990	.984	1.949	1.947	v.g.+
9	3.9	4.2	1.465	.652	.745	.824	.884	.917	.957	.969	.981	.983	.981	1.963	1.963	g.+
10	4.2	2.4	1.502	.641	.751	.841	.879	.922	.965	.979	.987	.990	.982	1.942	1.940	v.g.
17	6.7	12.7	1.376	.628	.720	.819	.846	.893	.937	.952	.963	.967	.964	1.959	1.961	g.
19	7.2	11.1	1.394	.630	.736	.828	.862	.910	.943	.962	.972	.973	.968	1.951	1.953	v.g.
22	7.4	15.1	1.358	.600	.720	.785	.846	.892	.933	.946	.958	.960	.962	1.979	1.979	v.g.
30	5.5	8.0	1.419	.625	.738	.814	.868	.913	.952	.959	.972	.980	.975	1.943	1.945	v.g.
31	6.7	9.9	1.392	.620	.727	.807	.847	.900	.943	.958	.968	.975	.965	1.955	1.957	g.+
Apr. 2	4.6	4.0	1.485	.634	.739	.827	.865	.923	.953	.971	.984	.986	.982	1.977	1.977	v.g.−
3	5.8	6.7	------	.606	.733	.820	.850	.902	.942	.966	.972	.975	.978	1.973	1.974	v.g.+
4	5.0	3.0	1.494	.630	.750	.838	.872	.915	.964	.973	.982	.985	.981	1.967	1.966	v.g.
5	3.8	4.8	1.467	.632	.755	.842	.867	.920	.959	.968	.971	.971	.972	1.977	1.977	v.g.+
6	4.9	3.6	1.481	.629	.750	.822	.867	.915	.953	.968	.978	.986	.980	1.980	1.980	v.g.
7	2.7	2.6	1.492	.626	.758	.845	.873	.917	.967	.973	.978	.982	.981	1.963	1.961	v.g.+
8	5.9	8.4	1.390	.628	.730	.821	.853	.906	.943	.961	.968	.973	.973	1.939	1.941	v.g.+
10	6.8	5.7	1.430	.620	.731	.820	.860	.902	.948	.959	.967	.972	.977	1.973	1.973	v.g.−
11	6.1	6.0	1.445	.631	.746	.834	.861	.913	.955	.967	.971	.975	.972	1.961	1.962	v.g.+
12	6.3	11.4	1.400	.597	.728	.810	.855	.902	.945	.958	.967	.972	.969	1.974	1.976	v.g.+
14	4.9	6.4	1.441	.620	.732	.818	.861	.908	.953	.967	.977	.985	.979	1.969	1.970	v.g.
15	4.5	8.3	1.417	.619	.725	.824	.852	.903	.953	.968	.976	.977	.979	1.964	1.966	v.g.+
16	4.3	7.6	------	.621	.750	.834	.857	.907	.952	.967	.972	.977	.972	1.938	1.939	v.g.+
18	3.7	6.8	------	.626	.739	.834	.862	.911	.953	.967	.979	.978	.977	1.962	1.963	e.−
19	3.5	2.6	1.513	.635	.736	.828	.867	.917	.962	.975	.987	.986	.985	1.971	1.969	v.g.
23	2.6	4.7	1.485	.629	.757	.846	.868	.919	.962	.975	.978	.982	.984	1.969	1.969	e.−
24	2.4	4.4	------	.641	.766	.845	.865	.921	.959	.972	.979	.982	.982	1.962	1.962	v.g.+
26	2.2	4.4	1.483	.634	.755	.839	.868	.919	.962	.972	.980	.982	.983	1.964	1.964	v.g.+
27	1.3	1.3	1.541	.648	.750	.845	.877	.915	.965	.976	.987	.989	.986	1.963	1.960	e.−
28	1.4	2.3	1.528	.651	.757	.843	.876	.917	.963	.973	.982	.985	.985	1.972	1.970	e.
May 2	1.5	3.1	1.497	.636	.750	.845	.874	.920	.967	.978	.987	.989	.989	1.945	1.945	e.
3	2.2	4.0	1.496	.634	.744	.838	.867	.919	.959	.975	.984	.988	.985	1.967	1.967	e.
10	1.1	1.0	1.543	.629	.764	.847	.882	.925	.969	.983	.989	.993	.992	1.950	1.947	v.g.+
12	1.7	2.6	1.504	.632	.745	.841	.866	.917	.964	.976	.986	.990	.985	1.954	1.952	e.−
21	2.3	6.0	1.462	.634	.736	.824	.865	.910	.960	.976	.988	.991	.987	1.954	1.955	e.−
27	1.7	4.0	1.491	.636	.742	.829	.870	.917	.967	.977	.983	.986	.983	1.971	1.971	v.g.
29	1.1	1.0	1.562	.612	.750	.833	.870	.920	.963	.975	.982	.987	.987	1.987	1.984	v.g.
31	0.7	1.0	1.554	.638	.752	.841	.876	.925	.969	.981	.987	.990	.983	1.979	1.976	e.−
June 1	0.7	1.5	1.545	.642	.741	.839	.872	.918	.969	.978	.988	.985	.987	1.962	1.959	v.g.
5	1.5	3.0	1.497	.617	.743	.832	.870	.913	.963	.977	.987	.992	.989	1.960	1.959	v.g.+
8	2.0	6.2	1.463	.634	.734	.824	.858	.913	.952	.967	.977	.980	.979	1.982	1.983	v.g.+
9	2.7	7.0	------	.641	.746	.830	.870	.918	.962	.973	.981	.982	.983	1.966	1.967	e.−

TABLE 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.349 μ	38 0.395 μ	32 0.450 μ	28 0.499 μ	22 0.621 μ	19 0.714 μ	17 0.803 μ	14 0.977 μ	11 1.214 μ	6 1.593 μ			
1923	*Mm*	*Mm*														
June 11	2.1	5.3	1.470	0.639	0.755	0.841	0.870	0.922	0.961	0.973	0.983	0.987	0.988	1.965	1.965	e.−
19	2.1	2.5	1.528	.634	.746	.830	.872	.917	.961	.972	.977	.985	.983	1.999	1.997	v.g.
20	0.8	1.3	1.542	.637	.759	.842	.873	.919	.962	.976	.982	.984	.980	1.980	1.977	v.g.+
22	1.0	1.0	1.531	.645	.754	.836	.877	.924	.965	.977	.985	.987	.988	1.978	1.975	g.+
23	1.3	2.9	1.500	.641	.749	.832	.872	.918	.961	.974	.985	.988	.983	1.971	1.969	e.
25	2.0	2.0	1.535	.650	.735	.833	.866	.916	.963	.976	.982	.989	.984	1.983	1.980	v.g.−
26	0.8	1.4	1.531	.644	.765	.836	.877	.922	.967	.978	.987	.991	.987	1.961	1.958	v.g.
27	0.9	0.7	1.557	.657	.745	.844	.874	.921	.962	.972	.978	.986	.980	1.979	1.976	v.g.−
28	0.8	1.2	1.551	.639	.760	.841	.875	.926	.968	.978	.988	.988	.992	1.971	1.968	e.−
29	0.8	1.4	1.539	.635	.754	.840	.872	.924	.962	.973	.983	.985	.985	1.991	1.988	e.−
July 6	0.6	0.6	1.567	.645	.752	.846	.874	.921	.963	.977	.984	.988	.985	1.980	1.977	e.−
7	0.4	1.4	1.507	.660	.772	.847	.882	.932	.969	.979	.987	.987	.986	1.921	1.918	g.+
12	0.6	1.2	1.534	.635	.765	.840	.875	.923	.966	.977	.988	.990	.988	1.961	1.958	e.
13	0.8	1.5	1.520	.647	.759	.853	.876	.923	.971	.981	.988	.989	.986	1.947	1.944	v.g.
24	1.0	0.6	1.554	.633	.751	.836	.871	.922	.964	.977	.983	.990	.987	1.977	1.974	e.
25	0.7	0.8	1.571	.629	.749	.845	.877	.922	.966	.978	.987	.992	.982	1.980	1.977	v.g.
Aug. 4	1.1	1.7	1.529	.637	.758	.847	.874	.921	.968	.982	.988	.990	.988	1.959	1.957	v.g.−
13	1.8	2.6	1.508	.636	.749	.837	.874	.918	.961	.973	.981	.983	.983	1.973	1.971	e.−
20	0.8	0.6	1.576	.639	.747	.834	.872	.914	.962	.975	.986	.987	.984	1.995	1.992	v.g.+
27	2.0	3.3	1.482	.626	.741	.828	.864	.910	.958	.972	.983	.985	.982	1.981	1.981	v.g.
Sept. 7	1.2	2.9	1.503	.637	.750	.832	.867	.918	.960	.972	.981	.986	.982	1.978	1.976	e.−
15	1.6	1.9	1.522	.625	.740	.831	.862	.910	.957	.969	.978	.985	.982	1.990	1.988	v.g.
20	1.2	1.4	1.538	.628	.754	.846	.883	.918	.963	.978	.987	.993	.984	1.969	1.967	e.−
21	1.1	1.8	1.535	.645	.754	.845	.878	.916	.963	.976	.983	.987	.985	1.972	1.970	e.
28	2.0	1.7	1.542	.640	.749	.844	.873	.917	.958	.974	.983	.989	.984	1.998	1.996	e.−
Oct. 6	1.4	1.7	1.529	.653	.760	.841	.876	.919	.963	.977	.982	.988	.987	1.958	1.956	v.g.
12	1.6	0.8	1.539	.624	.745	.838	.872	.916	.962	.974	.983	.990	.983	1.975	1.972	e.−
20	1.9	1.8	1.507	.620	.760	.838	.868	.916	.958	.972	.977	.981	.980	1.991	1.989	v.g.+
28	1.5	1.5	-------	.638	.752	.838	.869	.920	.964	.975	.982	.988	.983	1.967	1.965	g.+
Nov. 7	1.9	1.9	1.499	.624	.751	.838	.870	.919	.957	.972	.978	.983	.977	1.959	1.957	v.g.−
12	4.9	6.1	1.433	.614	.733	.823	.853	.902	.941	.957	.965	.973	.965	1.982	1.983	v.g.−
29	4.6	12.4	1.354	.605	.727	.810	.840	.897	.933	.948	.958	.963	.956	1.957	1.959	v.g.+
Dec. 10	3.5	9.1	1.398	.610	.736	.816	.849	.899	.941	.957	.966	.972	.965	1.958	1.960	v.g.+
29	3.1	8.0	1.408	.623	.728	.822	.852	.903	.946	.961	.969	.973	.967	1.961	1.963	v.g.+
1924																
Jan. 3	2.9	2.3	1.516	.633	.760	.842	.877	.923	.967	.977	.987	.988	.978	1.963	1.961	v.g.−
15	2.3	3.0	1.488	.625	.750	.840	.875	.915	.958	.968	.977	.982	.977	1.970	1.969	v.g.+
20	2.8	2.1	1.509	.643	.756	.846	.876	.919	.964	.976	.984	.987	.982	1.964	1.962	e.−
28	3.0	5.4	1.442	.629	.751	.838	.864	.908	.954	.965	.973	.976	.970	1.974	1.974	v.g.−
Feb. 4	3.9	12.5	1.361	.591	.714	.802	.834	.887	.924	.944	.953	.961	.957	1.986	1.988	v.g.−
23	5.9	9.8	1.395	.615	.735	.823	.846	.893	.937	.955	.965	.967	.963	1.990	1.992	e.−
28	5.0	4.6	1.453	.625	.738	.828	.855	.903	.949	.964	.974	.978	.976	1.981	1.981	v.g.−
Mar. 6	3.1	3.5	1.464	.630	.735	.832	.867	.908	.954	.968	.976	.982	.979	1.964	1.964	e.−
14	4.6	6.4	1.430	.620	.741	.832	.868	.913	.957	.968	.974	.980	.977	1.946	1.947	v.g.−
20	4.6	5.3	1.448	.626	.736	.833	.866	.910	.954	.968	.978	.981	.978	1.956	1.956	e.−
31	3.3	5.0	1.453	.612	.733	.824	.861	.910	.953	.967	.977	.981	.980	1.968	1.968	e.−
Apr. 10	4.7	8.6	1.439	.632	.749	.834	.867	.911	.957	.972	.977	.980	.975	1.954	1.956	v.g.+
14	2.1	2.6	1.449	.633	.758	.849	.880	.922	.966	.978	.987	.992	.987	1.926	1.924	e.−
18	2.9	8.6	-------	.645	.751	.842	.865	.921	.964	.973	.982	.986	.978	1.938	1.940	v.g.
28	1.7	1.2	1.524	.641	.763	.848	.878	.918	.971	.980	.987	.992	.987	1.945	1.943	v.g.+
May 5	2.7	2.1	1.500	.643	.759	.851	.882	.923	.962	.973	.982	.985	.983	1.949	1.947	e.−
15	2.8	5.1	1.464	.640	.756	.847	.870	.919	.962	.973	.980	.985	.988	1.950	1.950	e.−
22	1.5	1.0	1.544	.638	.767	.860	.882	.923	.970	.978	.984	.987	.985	1.962	1.959	v.g.+
30	1.2	0.5	1.567	.635	.745	.885	.877	.927	.967	.980	.988	.994	.990	1.956	1.953	v.g.+
June 3	1.8	3.0	1.500	.632	.765	.847	.874	.917	.963	.977	.985	.987	.987	1.968	1.967	e.−
22	2.7	3.1	1.496	.633	.753	.849	.871	.917	.962	.977	.988	.990	.990	1.963	1.963	e.−
26	2.3	3.9	1.479	.635	.751	.846	.872	.917	.965	.977	.985	.988	.987	1.949	1.949	e.−
29	1.4	0.6	1.564	.641	.755	.852	.878	.923	.967	.979	.988	.993	.988	1.964	1.961	v.g.
July 14	2.0	2.4	1.506	.645	.758	.846	.876	.921	.970	.979	.987	.990	.987	1.957	1.955	e.−
17	1.0	1.2	1.523	.632	.757	.842	.873	.917	.965	.975	.983	.988	.988	1.957	1.955	v.g.−
21	1.2	0.8	1.547	.637	.765	.855	.884	.917	.968	.979	.987	.990	.988	1.961	1.958	e.−
28	1.6	2.1	1.506	.645	.750	.843	.877	.917	.964	.975	.984	.989	.987	1.958	1.956	e.−

TABLE 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.349 μ	38 0.395 μ	32 0.450 μ	28 0.499 μ	22 0.621 μ	19 0.714 μ	17 0.803 μ	14 0.977 μ	11 1.214 μ	6 1.593 μ			
1924	*Mm*	*Mm*														
Aug. 15	2.5	6.5	1.443	0.625	0.747	0.841	0.873	0.912	0.957	0.973	0.982	0.987	0.982	1.948	1.949	e.−
19	1.9	2.9	1.470	.620	.732	.831	.868	.908	.957	.972	.984	.992	.988	1.951	1.950	e.−
22	2.0	3.4	1.337	.557	.672	.766	.811	.869	.928	.946	.966	.975	.977	1.921	1.921	v.g.−
23	1.9	2.7	1.436	.584	.703	.799	.837	.891	.943	.962	.977	.983	.982	1.975	1.974	v.g.
24	2.0	2.4	1.470	.628	.742	.829	.868	.905	.956	.969	.981	.988	.985	1.951	1.949	e.−
27	1.3	1.2	1.486	.618	.742	.827	.861	.898	.951	.963	.972	.978	.974	1.965	1.962	v.g.+
Sept. 11	3.2	3.1	1.493	.642	.746	.835	.876	.905	.957	.973	.984	.987	.985	1.961	1.960	v.g.
15	0.7	0.5	1.552	.639	.753	.844	.883	.923	.970	.981	.988	.993	.988	1.952	1.949	e.
25	2.0	3.7	1.521	.601	.709	.803	.835	.884	.930	.946	.958	.966	.968	1.988	1.988	v.g.−
Oct. 7	2.9	4.4	1.456	.627	.747	.829	.871	.908	.957	.970	.982	.987	.982	1.942	1.942	v.g.+
14	1.1	1.0	1.527	.633	.754	.850	.880	.913	.965	.977	.987	.989	.990	1.943	1.940	v.g.−
20	1.4	1.4	1.519	.625	.748	.843	.873	.917	.956	.968	.976	.979	.977	1.968	1.966	e.−
27	2.2	2.1	1.505	.634	.739	.838	.867	.898	.947	.959	.970	.977	.974	1.997	1.995	g.+
Nov. 3	1.8	0.6	1.558	.643	.750	.850	.882	.919	.964	.978	.986	.992	.983	1.959	1.956	v.g.+
8	1.7	0.5	1.565	.631	.755	.846	.882	.919	.963	.977	.986	.990	.986	1.963	1.960	e.
14	2.3	1.2	1.533	.630	.753	.845	.882	.915	.960	.972	.982	.984	.984	1.963	1.961	e.
19	3.6	4.2	1.443	.604	.740	.827	.862	.901	.944	.959	.966	.971	.967	1.967	1.967	e.−
22	2.7	1.5	1.502	.618	.744	.840	.875	.912	.960	.974	.984	.987	.985	1.954	1.952	v.g.+
Dec. 2	2.1	1.7	1.497	.620	.749	.845	.874	.912	.958	.972	.981	.983	.982	1.967	1.965	v.g.+
6	3.2	2.7	-------	.615	.730	.832	.863	.907	.952	.965	.976	.979	.977	1.961	1.960	v.g.
10	4.6	10.0	1.371	.596	.721	.815	.861	.891	.939	.955	.963	.969	.966	1.951	1.953	v.g.−
11	3.1	4.8	1.453	.629	.742	.835	.870	.912	.956	.970	.977	.981	.978	1.950	1.950	e.
18	3.2	3.9	1.468	.622	.746	.840	.873	.912	.955	.967	.977	.982	.981	1.961	1.961	e.−
19	2.9	3.4	-------	.618	.745	.836	.869	.907	.953	.968	.978	.980	.980	1.974	1.974	v.g.−
21	2.5	4.0	-------	.624	.742	.835	.869	.907	.954	.968	.976	.979	.980	1.947	1.947	g.+
22	2.8	5.3	1.441	.617	.738	.833	.867	.907	.951	.967	.973	.977	.976	1.970	1.970	e.−
23	3.2	9.1	-------	.589	.720	.815	.852	.897	.939	.953	.961	.968	.970	1.963	1.965	v.g.−
24	3.3	9.2	1.390	.602	.744	.812	.847	.892	.936	.952	.865	.971	.969	1.976	1.978	e.−
25	2.9	4.0	1.463	.619	.743	.836	.867	.909	.955	.967	.976	.978	.978	1.959	1.959	e.−
26	3.4	4.7	1.429	.608	.738	.822	.859	.899	.939	.956	.964	.967	.966	1.979	1.979	v.g.−
27	5.6	11.7	1.307	.579	.696	.786	.819	.871	.913	.932	.942	.949	.947	1.961	1.963	g.
28	2.2	9.2	1.352	.592	.706	.801	.840	.883	.924	.943	.953	.957	.957	1.963	1.965	v.g.
1925																
Jan. 3	3.7	11.6	1.356	.594	.721	.813	.847	.892	.933	.948	.958	.962	.962	1.950	1.952	e.−
5	5.1	16.2	1.336	.586	.706	.804	.841	.888	.929	.948	.959	.967	.963	1.937	1.937	g.
8	3.8	9.0	1.397	.605	.725	.823	.853	.896	.941	.956	.963	.968	.963	1.965	1.967	v.g.
9	4.2	6.6	1.410	.618	.736	.827	.863	.903	.948	.963	.972	.977	.975	1.941	1.942	g.
10	4.1	5.7	1.435	.618	.731	.829	.861	.902	.944	.958	.967	.973	.969	1.967	1.967	e.−
11	3.8	5.4	1.433	.608	.743	.832	.871	.912	.951	.966	.972	.977	.975	1.947	1.947	v.g.+
13	5.5	13.0	-------	.596	.716	.799	.842	.885	.927	.942	.952	.958	.957	1.955	1.956	v.g.−
14	3.5	8.8	1.390	.610	.732	.820	.856	.897	.941	.952	.962	.966	.967	1.953	1.955	v.g.
19	4.4	9.3	-------	.598	.724	.769	.860	.899	.943	.962	.972	.974	.977	1.937	1.939	g.+
24	6.7	18.1	1.331	.592	.707	.805	.837	.882	.919	.938	.949	.953	.952	1.967	1.967	v.g.−
Feb. 17	5.7	12.1	1.406	.623	.735	.832	.865	.905	.947	.962	.970	.970	.971	1.954	1.956	v.g.
27	6.5	13.5	1.397	.615	.725	.820	.857	.898	.941	.957	.965	.969	.967	1.970	1.971	v.g.
28	7.1	14.9	1.366	.603	.718	.813	.848	.892	.932	.947	.957	.959	.958	1.957	1.958	g.
Mar. 4	6.0	12.0	-------	.628	.745	.831	.868	.905	.943	.958	.965	.968	.967	1.933	1.935	g.+
6	7.9	13.1	1.384	.596	.721	.816	.853	.899	.939	.957	.965	.968	.967	1.956	1.957	g.+
11	5.7	10.3	1.416	.619	.735	.832	.867	.908	.951	.967	.976	.977	.976	1.940	1.942	v.g.−
12	5.9	12.5	1.394	.612	.729	.823	.859	.898	.943	.959	.967	.971	.969	1.953	1.955	v.g.
13	6.4	12.4	1.388	.602	.723	.822	.859	.902	.944	.960	.968	.971	.972	1.939	1.941	v.g.−
14	6.0	10.1	1.409	.608	.729	.825	.862	.903	.946	.958	.968	.971	.970	1.944	1.946	v.g.−
15	5.2	11.0	1.395	.603	.727	.824	.867	.907	.943	.966	.970	.969	.971	1.942	1.944	v.g.+
16	5.3	8.7	1.421	.618	.723	.826	.866	.902	.947	.961	.972	.974	.972	1.955	1.957	g.+
18	5.9	13.7	1.368	.575	.710	.808	.853	.893	.936	.950	.960	.962	.965	1.957	1.958	g.+
23	6.5	9.0	1.422	.590	.720	.815	.866	.905	.845	.962	.974	.975	.978	1.962	1.964	v.g.+
24	4.8	9.0	1.431	.590	.735	.814	.867	.910	.950	.965	.975	.975	.976	1.960	1.962	v.g.−
25	5.1	9.8	1.423	.603	.728	.823	.859	.908	.949	.963	.977	.975	.977	1.964	1.966	e.−
26	4.4	9.8	1.428	.600	.729	.817	.864	.907	.948	.963	.971	.977	.977	1.949	1.951	v.g.
27	5.1	10.2	1.419	.581	.734	.815	.869	.910	.948	.961	.971	.975	.974	1.965	1.967	v.g.
28	6.2	11.8	1.400	.587	.724	.814	.865	.908	.941	.959	.969	.974	.972	1.964	1.966	g.+
29	7.0	13.1	1.382	.585	.722	.813	.857	.896	.936	.951	.960	.960	.962	1.976	1.977	v.g.−
30	6.0	9.3	1.438	.600	.729	.820	.867	.908	.946	.959	.971	.970	.971	1.982	1.984	g.+
31	5.9	9.5	1.433	.604	.735	.826	.867	.909	.947	.961	.969	.979	.971	1.971	1.973	v.g.+

TABLE 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.349 μ	38 0.395 μ	32 0.450 μ	28 0.499 μ	22 0.621 μ	19 0.714 μ	17 0.803 μ	14 0.977 μ	11 1.214 μ	6 1.593 μ			
1925	*Mm*	*Mm*														
Apr. 1	5.7	7.2	1.463	0.600	0.741	0.832	0.874	0.912	0.951	0.965	0.975	0.976	0.975	1.979	1.980	e.—
2	5.3	7.6	1.444	.599	.740	.826	.872	.910	.950	.961	.970	.970	.972	1.981	1.982	v.g.
3	5.0	6.2	1.465	.596	.744	.834	.874	.911	.954	.965	.976	.975	.975	1.970	1.971	v.g.+
4	4.4	8.6	1.419	.605	.745	.828	.867	.910	.948	.964	.973	.972	.975	1.949	1.951	g.
5	4.0	6.2	1.467	.600	.740	.836	.876	.911	.954	.968	.977	.978	.982	1.971	1.972	v.g.+
6	3.6	4.8	1.480	.614	.745	.836	.879	.907	.953	.963	.970	.970	.980	1.971	1.971	v.g.+
7	3.6	4.4	1.479	.605	.750	.839	.879	.920	.961	.971	.982	.980	.980	1.948	1.948	v.g.+
8	5.2	6.5	1.453	.595	.735	.828	.877	.903	.950	.966	.975	.976	.980	1.971	1.972	v.g.+
13	6.1	1.0	1.494	.621	.744	.839	.884	.918	.966	.980	.990	.992	.992	1.936	1.933	v.g.
14	5.5	2.8	1.504	.605	.750	.835	.880	.912	.960	.968	.979	.980	.984	1.965	1.963	e.—
15	2.8	3.3	1.489	.602	.730	.824	.873	.913	.955	.968	.978	.980	.980	1.977	1.977	v.g.+
17	3.2	5.7	1.464	.603	.750	.832	.873	.914	.958	.970	.978	.976	.980	1.948	1.948	v.g.+
21	3.2	4.2	1.493	.617	.744	.838	.874	.916	.960	.970	.979	.980	.980	1.961	1.961	v.g.+
22	2.6	2.9	1.500	.611	.755	.838	.876	.914	.958	.971	.980	.983	.980	1.953	1.952	e.—
23	3.9	3.7	1.495	.616	.745	.834	.873	.916	.960	.968	.980	.980	.980	1.967	1.967	e.—
30	3.5	4.3	1.483	.606	.721	.821	.852	.898	.950	.963	.975	.976	.976	1.974	1.974	v.g.+
May 1	3.2	2.6	1.512	.605	.744	.835	.876	.918	.960	.970	.979	.981	.983	1.960	1.958	e.—
2	------	2.3	1.523	.630	.756	.838	.879	.923	.960	.973	.981	.981	.982	1.953	1.951	e.
3	2.2	2.0	1.527	.606	.737	.839	.876	.919	.959	.967	.977	.979	.981	1.966	1.964	e.
4	1.9	1.1	1.543	.619	.740	.833	.873	.918	.956	.969	.977	.979	.981	1.972	1.969	e.—
5	1.3	1.1	1.551	.616	.745	.845	.879	.916	.960	.972	.980	.982	.982	1.975	1.972	e.—
8	2.8	4.1	1.498	.626	.747	.830	.878	.918	.959	.974	.980	.981	.980	1.966	1.966	e.—
9	1.5	2.6	1.516	.621	.757	.840	.881	.970	.960	.971	.980	.978	.980	1.966	1.964	e.
10	2.9	1.1	1.559	.641	.755	.842	.878	.922	.963	.976	.984	.986	.984	1.960	1.957	e.
12	2.9	3.5	1.507	.627	.759	.841	.880	.922	.961	.971	.980	.979	.981	1.955	1.955	e.
13	1.5	2.0	1.525	.617	.752	.838	.881	.917	.962	.970	.983	.982	.977	1.960	1.958	e.—
14	1.4	2.5	1.527	.614	.745	.834	.880	.917	.961	.973	.986	.985	.981	1.974	1.972	e.—
15	1.7	2.4	1.522	.622	.754	.835	.884	.919	.956	.971	.977	.977	.975	1.963	1.961	e.—
16	1.5	1.7	1.538	.623	.754	.833	.878	.915	.958	.970	.979	.980	.975	1.983	1.981	e.—
17	2.2	5.3	1.490	.614	.756	.844	.877	.920	.962	.972	.981	.981	.980	1.960	1.960	e.
22	3.3	7.5	1.458	.618	.746	.831	.877	.917	.955	.969	.977	.983	.980	1.953	1.954	e.—
31	2.2	2.8	1.507	.627	.752	.844	.877	.919	.964	.972	.982	.984	.983	1.950	1.948	e.—
June 1	2.4	2.4	1.514	.624	.760	.841	.885	.926	.970	.978	.987	.989	.986	1.941	1.939	e.—
2	2.6	3.0	1.516	.613	.750	.841	.877	.916	.966	.972	.984	.984	.983	1.958	1.957	e.—
3	1.7	1.5	1.536	.622	.759	.839	.886	.923	.968	.976	.983	.986	.988	1.964	1.962	v.g.+
16	2.8	2.5	1.515	.639	.756	.840	.882	.917	.963	.975	.983	.988	.987	1.952	1.950	e.—
17	1.9	2.5	1.505	.624	.764	.830	.873	.919	.962	.974	.984	.986	.986	1.962	1.960	v.g.+
18	2.8	3.0	1.504	.632	.742	.841	.878	.913	.958	.970	.979	.980	.984	1.969	1.968	e.—
19	1.9	1.3	1.536	.629	.751	.843	.883	.915	.963	.976	.987	.990	.986	1.941	1.939	e.—
21	3.6	4.1	1.491	.620	.750	.838	.874	.918	.963	.973	.981	.984	.984	1.954	1.954	v.g.+
22	3.2	2.8	1.524	.642	.746	.839	.877	.917	.961	.975	.983	.986	.984	1.971	1.970	e.—
23	1.4	2.1	1.533	.617	.755	.833	.880	.920	.962	.977	.985	.981	.980	1.974	1.972	e.—
24	1.2	1.0	1.569	.623	.745	.834	.879	.921	.963	.973	.987	.984	.983	1.977	1.974	e.—
25	1.2	1.3	1.554	.627	.745	.840	.884	.925	.966	.978	.985	.988	.987	1.968	1.966	e.
26	1.0	0.9	1.571	.630	.748	.835	.882	.920	.967	.976	.986	.989	.987	1.975	1.972	e.
27	1.0	1.1	1.556	.626	.761	.838	.882	.920	.965	.975	.985	.985	.983	1.972	1.969	e.
29	1.2	2.2	1.522	.616	.749	.841	.876	.920	.962	.972	.982	.981	.981	1.960	1.958	e.—
July 1	1.6	2.9	1.505	.610	.740	.820	.872	.914	.960	.968	.977	.984	.985	1.967	1.965	v.g.+
3	1.8	4.4	1.480	.631	.752	.835	.879	.922	.964	.976	.981	.985	.985	1.946	1.946	e.—
13	1.9	3.8	1.498	.625	.748	.838	.877	.916	.965	.976	.989	.988	.988	1.949	1.949	e.—
16	2.2	4.6	1.489	.636	.750	.840	.881	.924	.961	.970	.981	.982	.981	1.956	1.956	e.
20	2.7	3.8	1.509	.621	.751	.840	.881	.920	.960	.973	.983	.984	.984	1.958	1.958	e.
24	1.6	1.9	1.536	.626	.746	.830	.881	.923	.963	.974	.986	.984	.986	1.966	1.964	e.
30	2.2	4.9	1.471	.624	.741	.834	.873	.917	.960	.972	.980	.982	.983	1.944	1.944	e.—
31	2.5	5.0	1.465	.616	.739	.823	.870	.917	.958	.969	.978	.979	.979	1.952	1.952	e.—
Aug. 5	1.0	0.7	1.590	.643	.756	.842	.884	.924	.967	.978	.984	.985	.987	1.961	1.958	e.
7	0.9	0.7	1.587	.643	.751	.841	.882	.920	.954	.975	.987	.988	.989	1.966	1.963	e.
Sept. 7	2.2	4.2	1.482	.623	.754	.834	.877	.917	.961	.973	.979	.980	.981	1.960	1.960	e.
15	1.1	1.1	1.557	.610	.747	.836	.874	.917	.959	.974	.982	.984	.979	1.976	1.973	e.
24	2.5	2.2	1.523	.630	.745	.837	.879	.916	.960	.974	.984	.985	.984	1.964	1.962	e.
30	1.5	2.1	1.528	.626	.752	.838	.878	.919	.966	.976	.984	.984	.982	1.970	1.968	e.—
Oct. 8	1.4	1.4	1.536	.620	.750	.836	.879	.917	.963	.973	.984	.986	.984	1.966	1.964	e.
13	2.3	2.5	1.524	.628	.750	.841	.879	.918	.961	.973	.982	.982	.983	1.969	1.967	e.

TABLE 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.349 μ	38 0.395 μ	32 0.450 μ	28 0.499 μ	22 0.621 μ	19 0.714 μ	17 0.803 μ	14 0.977 μ	11 1.214 μ	6 1.593 μ			
1925	*Mm*	*Mm*														
Oct. 16	2 1	2.6	1.520	0.624	0.756	0.840	0.878	0.917	0.959	0.972	0.980	0.981	0.981	1.974	1.972	e.
30	2.3	3.3	1.508	.630	.756	.836	.877	.917	.961	.971	.981	.981	.980	1.967	1.967	e.—
Nov. 10	2.0	6.1	1.443	.617	.737	.818	.866	.908	.950	.963	.973	.975	.972	1.956	1.956	e.—
19	3.8	7.7	1.449	.621	.740	.826	.868	.912	.954	.967	.975	.977	.976	1.967	1.968	e.—
Dec. 4	3.7	8.5	1.437	.604	.744	.824	.864	.905	.945	.955	.965	.971	.975	1.988	1.990	v.g.
29	4.9	7.6	1.431	.610	.739	.821	.865	.905	.946	.960	.966	.971	.970	1.946	1.947	e.—
1926																
Jan. 11	3.4	5.2	1.452	.621	.750	.831	.874	.916	.952	.966	.978	.977	.976	1.938	1.938	v.g.
Feb. 15	6.9	10.1	1.429	.612	.730	.818	.873	.917	.955	.970	.975	.977	.981	1.951	1.953	g.
Mar. 12	6.4	12.3	1.388	.592	.722	.801	.853	.902	.942	.955	.966	.964	.966	1.971	1.973	v.g.
29	4.1	9.4	1.414	.594	.728	.815	.863	.905	.947	.958	.964	.967	.970	1.965	1.967	v.g.
Apr. 5	3.5	6.3	1.435	.595	.729	.817	.863	.916	.952	.967	.976	.980	.980	1.952	1.953	v.g.
8	4.2	6.9	1.450	.597	.741	.815	.863	.915	.948	.964	.977	.975	.976	1.955	1.956	e.—
15	1.9	1.8	1.536	.630	.750	.839	.879	.921	.963	.972	.982	.985	.985	1.969	1.967	e.—
20	2.8	4.1	1.467	.596	.736	.826	.877	.918	.957	.971	.980	.980	.980	1.949	1.949	e.
May 6	2.3	3.9	1.490	.611	.745	.836	.868	.917	.957	.968	.979	.982	.983	1.958	1.958	v.g.
27	2.6	4.1	1.485	-------	.750	.834	.860	.924	.962	.973	.982	.985	.982	1.938	1.938	v.g.
July 5	2.4	1.0	1.551	.645	.753	.842	.888	.926	.969	.980	.990	.990	.982	1.961	1.958	v.g.+
13	2.4	5.2	1.485	.613	.760	.838	.887	.929	.970	.982	.989	.991	.989	1.930	1.930	v.g.
22	2.1	2.1	1.526	.625	.750	.830	.874	.916	.955	.967	.976	.979	.975	1.959	1.957	e.—
Aug. 6	1.4	0.7	1.577	.637	.743	.843	.884	.923	.967	.978	.985	.989	.987	1.960	1.957	v.g.
31	2.8	3.8	1.484	.631	.746	.825	.873	.908	.960	.974	.982	.992	.987	1.953	1.953	e.—
Oct. 9	4.7	3.7	1.483	.636	.756	.835	.880	.918	.959	.970	.978	.979	.982	1.951	1.951	e.—
15	3.6	1.7	1.527	.627	.760	.848	.883	.927	.968	.980	.988	.988	.987	1.931	1.929	e.
19	1.6	1.1	1.552	.628	.755	.832	.862	.904	.959	.973	.984	.981	.986	1.970	1.967	v.g.+
Nov. 2	1.7	1.0	1.535	.622	.766	.845	.883	.919	.963	.975	.983	.982	.984	1.924	1.921	e.—
25	3.9	11.5	1.373	.596	.709	.802	.849	.892	.933	.946	.961	.960	.969	1.957	1.959	v.g.+
1927																
Jan. 4	5.5	9.5	1.414	.609	.737	.823	.863	.907	.947	.958	.965	.965	.973	1.932	1.934	v.g.
Feb. 12	3.3	3.2	-------	.621	.744	.837	.880	.917	.959	.970	.978	.980	.979	1.968	1.968	v.g.
Mar. 21	5.6	9.7	1.436	.621	.743	.830	.869	.910	.954	.966	.973	.975	.977	1.943	1.945	v.g.
Apr. 3	2.6	1.4	1.534	.609	.751	.840	.880	.916	.959	.973	.981	.880	.984	1.966	1.964	e.—
13	3.1	3.2	1.495	.600	.742	.838	.880	.918	.959	.970	.980	.983	.983	1.969	1.969	v.g.+
20	3.5	4.8	1.492	.605	.752	.836	.881	.919	.958	.969	.979	.979	.981	1.952	1.952	v.g.
27	1.6	3.5	1.503	.618	.755	.840	.879	.920	.961	.975	.984	.984	.985	1.947	1.947	v.g.
May 3	2.6	3.2	1.507	.616	.760	.844	.879	.917	.962	.973	.981	.981	.982	1.960	1.960	e.—
10	1.5	1.5	1.539	.614	.751	.841	.876	.921	.959	.974	.982	.984	.981	1.966	1.964	e.—
24	1.6	0.9	1.561	.619	.771	.849	.883	.924	.963	.974	.983	.984	.981	1.956	1.953	v.g.
June 8	1.8	3.2	1.507	.620	.755	.833	.878	.921	.962	.976	.985	.984	.983	1.964	1.964	v.g.
24	3.3	3.9	1.482	.628	.760	.842	.880	.922	.963	.975	.983	.983	.984	1.944	1.944	v.g.+
28	0.9	1.4	1.525	.634	.760	.847	.884	.926	.966	.975	.988	.987	.986	1.942	1.940	v.g.
July 11	1.1	1.2	1.544	.625	.750	.826	.882	.923	.960	.974	.981	.980	.985	1.970	1.968	v.g.
18	1.4	1.3	1.530	.617	.751	.841	.877	.919	.960	.970	.981	.984	.986	1.976	1.974	v.g.
25	0.7	0.7	1.564	.606	.760	.854	.941	.939	.969	.978	.985	.988	.984	1.935	1.932	v.g.
Aug. 1	1.9	3.6	1.493	.608	.745	.831	.876	.922	.962	.977	.984	.986	.985	1.961	1.961	v.g.+
8	0.6	0.4	1.588	.625	.756	.853	.887	.921	.961	.979	.989	.987	.986	1.988	1.985	e.—
16	1.2	1.3	1.546	.622	.758	.821	.883	.923	.965	.977	.985	.989	.984	1.964	1.962	v.g.
30	2.0	5.7	1.483	.613	.750	.842	.887	.926	.968	.980	.987	.988	.987	1.960	1.960	v.g.+
Sept. 12	1.5	1.5	1.528	.622	.749	.837	.880	.919	.963	.977	.985	.984	.985	1.962	1.960	v.g.+
20	1.0	1.3	1.550	.616	.748	.845	.884	.923	.965	.976	.983	.984	.985	1.977	1.975	v.g.+
Oct. 4	1.8	2.1	1.513	.626	.752	.830	.877	.917	.963	.973	.983	.986	.986	1.973	1.971	v.g.
12	1.9	3.1	1.502	.621	.750	.841	.879	.923	.963	.973	.982	.981	.981	1.971	1.971	e.—
22	3.5	2.8	1.505	.623	.740	.841	.882	.933	.964	.976	.984	.985	.985	1.963	1.961	v.g.+
Nov. 3	1.9	2.4	1.513	.626	.757	.842	.878	.919	.962	.974	.984	.985	.987	1.969	1.967	v.g.
10	1.7	1.7	1.529	.611	.754	.841	.878	.924	.960	.973	.984	.986	.986	1.981	1.979	v.g.
23	5.0	4.8	1.449	.604	.741	.825	.862	.904	.945	.959	.968	.972	.973	1.988	1.988	v.g.
Dec. 2	1.5	3.0	1.510	.625	.760	.851	.886	.927	.964	.977	.987	.990	.992	1.958	1,958	v.g.
10	3.5	5.8	1.438	.616	.740	.832	.868	.914	.946	.964	.974	.975	.980	1.980	1.980	g.
1928																
Jan. 3	2.2	2.8	1.496	.620	.751	.843	.878	.921	.962	.975	.982	.982	.983	1.955	1.953	v.g.
Feb. 7	4.1	5.4	1.469	.662	.746	.841	.872	.921	.953	.968	.975	.976	.980	1.979	1.979	g.
Mar. 9	4.0	3.7	1.492	.617	.750	.844	.880	.920	.954	.968	.984	.985	.985	1.996	1.996	g.

TABLE 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46, 0.349 μ	38, 0.395 μ	32, 0.450 μ	28, 0.499 μ	22, 0.621 μ	19, 0.714 μ	17, 0.803 μ	14, 0.977 μ	11, 1.214 μ	6, 1.593 μ	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1928	*Mm*	*Mm*														
Apr. 9	3.0	2.1	1.532	0.619	0.757	0.848	0.880	0.926	0.968	0.976	0.986	0.984	0.983	1.957	1.955	v.g.+
28	5.5	3.6	1.491	.604	.765	.845	.874	.922	.953	.978	.986	.985	.985	1.949	1.949	v.g.−
May 11	4.1	1.6	1.547	.611	.750	.846	.889	.931	.968	.980	.986	.984	.986	1.980	1.978	g.
22	4.4	8.2	1.457	.630	.766	.848	.884	.927	.967	.979	.985	.986	.986	1.958	1.960	g.
30	3.5	5.7	1.471	.611	.768	.849	.884	.930	.961	.979	.984	.986	.985	1.950	1.950	g.
June 9	2.2	1.8	1.534	.633	.764	.848	.885	.927	.969	.979	.986	.986	.980	1.951	1.949	g.
July 3	2.0	1.1	1.556	.606	.758	.856	.890	.930	.970	.982	.986	.983	.981	1.972	1.970	v.g.−
25	4.4	2.0	1.531	.608	.756	.840	.879	.920	.969	.978	.886	.984	.985	1,973	1.971	v.g.
Aug. 6	4.5	2.4	1.528	.615	.758	.855	.888	.929	.972	.983	.986	.986	.985	1.957	1.955	v.g.−
14	3.9	0.4	1.578	.609	.759	.854	.884	.924	.966	.977	.985	.986	.985	1.975	1.972	v.g.−
20	3.7	2.6	1.505	.602	.738	.836	.872	.920	.962	.980	.985	.985	.985	1.972	1.970	g.+
Sept. 20	3.4	5.3	1.457	.604	.746	.840	.875	.918	.961	.976	.985	.983	.984	1.944	1.944	v.g.
Oct. 2	2.3	4.3	1.463	.576	.731	.814	.849	.900	.942	.958	.970	.975	.975	1.975	1.975	v.g.
9	2.7	2.2	1.493	.624	.733	.816	.851	.904	.949	.964	.975	.974	.974	1.954	1.952	v.g.
19	3.3	4.0	1.476	.611	.743	.830	.863	.914	.956	.967	.977	.976	.977	1.955	1.955	v.g.
29	2.9	3.5	1.484	.591	.732	.831	.871	.913	.954	.965	.975	.986	.980	1.956	1.956	v.g.−
Nov. 22	3.6	5.4	1.454	.592	.725	.833	.869	.910	.957	.967	.974	.978	.975	1.948	1.948	g.
27	3.2	5.5	1.434	.607	.734	.827	.864	.906	.951	.963	.972	.977	.969	1.931	1.931	v.g.
Dec. 5	4.1	7.5	1.316	.545	.708	.803	.826	.860	.909	.925	.934	.939	.950	1.953	1.954	g.−
13	2.6	2.9	1.477	.606	.731	.827	.870	.910	.954	.965	.976	.982	.981	1.943	1.942	v.g.−
20	3.9	3.6	1.457	.585	.734	.832	.861	.906	.951	.965	.976	.978	.975	1.930	1.930	v.g.−
1929																
Jan. 17	6.4	6.9	1.446	.613	.744	.836	.871	.915	.953	.969	.974	.977	.980	1.937	1.938	v.g.−
Feb. 5	5.9	12.3	1.364	.605	.715	.815	.864	.906	.951	.966	.975	.977	.984	1.946	1.948	v.g.
Mar. 14	6.9	12.2	1.370	.594	.711	(.810)	.860	.906	.952	.970	.980	.984	.985	1.954	1.956	v.g.
23	6.4	4.6	1.461	.621	.728	.827	.878	.918	.961	.974	.982	.985	.987	1.968	1.968	v.g.
Apr. 5	4.7	7.0	1.433	.623	.725	.816	.871	.910	.953	.967	.979	.981	.986	1.982	1.983	v.g.
11	4.2	2.3	1.520	.630	.754	.841	.895	.927	.972	.985	.989	.989	.991	1.956	1.954	v.g.−
16	2.8	2.3	1.522	.625	.745	.840	.891	.924	.970	.981	.986	.987	.986	1.972	1.970	v.g.
22	2.2	2.0	1.510	.633	.746	.838	.886	.922	.969	.980	.987	.986	.986	1.964	1.962	g.+
27	4.8	3.3	1.493	.621	.740	.835	.886	.922	.966	.980	.988	.985	.986	1.964	1.964	g.
May 5	4.7	5.9	1.456	.631	.735	.830	.875	.925	.974	.980	.986	.983	.988	1.955	1.955	g.−
11	4.0	2.9	-------	.645	.750	.845	.891	.921	.972	.985	.988	.985	.988	1.956	1.955	g.−
17	4.6	3.5	1.486	.641	.741	.834	.884	.925	.969	.978	.987	.986	.985	1.963	1.963	v.g.
23	4.5	6.0	1.448	.635	.741	.833	.881	.923	.963	.978	.988	.988	.985	1.974	1.974	v.g.
28	3.2	2.0	1.512	.630	.747	.839	.886	.922	.971	.984	.987	.988	.986	1.970	1.968	v.g.
June 5	3.8	6.6	1.453	.622	.750	.834	.883	.920	.962	.980	.982	.985	.987	1.961	1.962	g.
12	3.0	3.7	1.474	.634	.741	.835	.886	.918	.965	.980	.985	.985	.986	1.948	1.948	g.+
24	2.6	0.9	1.549	.640	.750	.835	.884	.925	.961	.983	.986	.985	.986	1.971	1.968	g.+
25	3.3	0.9	1.550	.632	.740	.828	.880	.916	.960	.977	.980	.983	.986	1.988	1.985	v.g.+
July 1	4.0	3.6	1.487	.639	.743	.833	.885	.916	.970	.980	.986	.983	.984	1.960	1.960	v.g.+
6	3.2	5.1	1.466	.632	.725	.826	.878	.917	.964	.978	.986	.984	.984	1.962	1.962	v.g.+
11	3.0	1.8	1.523	.650	.744	.844	.884	.922	.968	.979	.985	.984	.980	1.953	1.951	g.+
15	3.4	3.2	1.484	.596	.730	.824	.875	.910	.962	.972	.985	.980	.985	1.978	1.978	v.g.+
22	1.7	2.0	1.518	.625	.735	.826	.880	.914	.962	.975	.984	.986	.984	1.974	1.972	v.g.−
30	3.1	1.8	1.517	.623	.738	.821	.881	.923	.965	.980	.985	.980	.986	1.941	1.939	v.g.−
Aug. 5	2.0	0.8	1.551	.627	.741	.826	.878	.915	.961	.985	.984	.985	.985	1.980	1.977	v.g.+
13	2.5	1.6	1.524	.621	.747	.835	.885	.916	.964	.978	.986	.984	.986	1.963	1.961	v.g.+
17	2.8	2.2	1.504	.618	.735	.818	.876	.911	.959	.970	.984	.985	.986	1.979	1.977	v.g.
25	1.1	1.1	1.545	.642	.751	.834	.889	.919	.969	.984	.983	.980	.988	1.957	1.954	v.g.
Sept. 4	1.9	4.4	1.466	.635	.740	.825	.876	.910	.960	.973	.985	.981	.984	1.956	1.956	v.g.
9	1.3	1.6	1.519	.636	.744	.830	.877	.925	.955	.971	.985	.981	.980	1.951	1.949	v.g.
14	1.1	0.8	1.545	.631	.744	.830	.880	.916	.961	.971	.983	.981	.978	1.965	1.962	v.g.−
21	1.8	2.5	1.490	.621	.740	.825	.874	.907	.956	.968	.980	.981	.984	1.954	1.952	v.g.−
22	2.5	5.2	1.442	.615	.736	.820	.866	.908	.956	.970	.978	.976	.985	1.944	1.944	v.g.+
29	3.0	1.9	1.513	.634	.744	.826	.881	.911	.960	.972	.985	.980	.985	1.956	1.954	v.g.+
Oct. 5	2.7	1.7	1.506	.624	.740	.833	.881	.907	.957	.969	.979	.979	.980	1.955	1.953	v.g.
17	3.4	3.1	1.488	.623	.729	.821	.871	.910	.958	.970	.980	.985	.986	1.962	1.962	v.g.+
Nov. 2	3.4	6.8	1.438	.604	.731	.825	.871	.906	.955	.966	.977	.978	.985	1.954	1.955	v.g.−
4	3.1	1.2	1.530	.640	.746	.836	.883	.916	.961	.973	.984	.984	.983	1.950	1.948	v.g.
9	3.0	1.6	1.525	.631	.741	.834	.882	.912	.959	.970	.983	.982	.990	1.961	1.959	v.g.+
13	3.8	2.1	1.403	.601	.706	.790	.831	.869	.906	.926	.930	.927	.945	1.997	1.995	g.−

TABLE 28.—*Solar-constant values. Long method. Montezuma, 1920–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46, 0.349 μ	38, 0.395 μ	32, 0.450 μ	28, 0.499 μ	22, 0.621 μ	19, 0.714 μ	17, 0.803 μ	14, 0.977 μ	11, 1.214 μ	6, 1.593 μ	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1929	*Mm*	*Mm*														
Nov. 24	3.8	2.7	1.491	0.629	0.737	0.831	0.879	0.910	0.955	0.966	.982	0.983	0.984	1.955	1.953	v.g.
29	3.5	2.6	1.502	.624	.741	.827	.876	.911	.955	.967	.977	.974	.986	1.973	1.971	v.g.
Dec. 5	4.0	3.8	1.482	.637	.736	.827	.877	.911	.956	.963	.978	.979	.985	1.958	1.958	v.g.
11	3.4	3.8	1.470	.633	.744	.836	.880	.913	.958	.970	.980	.976	.983	1.948	1.948	v.g.
19	4.6	3.6	1.482	.645	.742	.830	.875	.910	.953	.970	.978	.977	.985	1.964	1.964	v.g.
28	6.2	9.2	1.410	.621	.732	.823	.874	.908	.955	.971	.979	.976	.983	1.939	1.941	v.g.
1930																
Jan. 15	5.9	12.0	------	.612	.721	.811	.860	.895	.947	.963	.971	.967	.980	1.980	1.982	v.g.−
Feb. 4	5.3	8.8	1.407	.617	.724	.823	.870	.905	.955	.969	.976	.980	.985	1.934	1.936	v.g.
8	5.2	8.7	1.406	.620	.724	.815	.861	.901	.947	.960	.968	.970	.980	1.953	1.955	v.g.−
24	7.0	10.3	1.374	.615	.716	.805	.855	.892	.935	.950	.961	.960	.970	1.963	1.965	v.g.−
Mar. 4	4.9	11.9	1.372	.622	.724	.822	.857	.900	.940	.959	.963	.967	.975	1.956	1.958	v.g.
12	4.6	5.6	1.449	.620	.727	.826	.872	.910	.954	.967	.979	.980	.986	1.953	1.953	v.g.
17	5.2	7.3	1.430	.620	.734	.821	.875	.910	.952	.969	.975	.975	.986	1.950	1.951	v.g.+
24	5.6	5.1	1.477	.617	.754	.830	.880	.912	.963	.979	.984	.984	.989	1.956	1.956	v.g.+
25	5.3	6.5	1.470	.645	.736	.826	.875	.913	.956	.967	.980	.980	.988	1.974	1.975	v.g.+
Apr. 2	2.7	5.8	1.450	.625	.726	.821	.870	.908	.952	.967	.974	.976	.984	1.962	1.962	v.g.+
9	3.2	3.8	1.486	.624	.742	.831	.881	.917	.962	.975	.985	.978	.987	1.962	1.962	v.g.+
16	2.2	5.4	1.457	.626	.736	.820	.875	.912	.960	.970	.984	.984	.988	1.956	1.956	v.g.+
22	4.3	6.7	1.439	.631	.730	.816	.870	.910	.954	.969	.977	.979	.982	1.953	1.954	v.g.
28	3.0	2.8	1.510	.625	.745	.832	.880	.919	.963	.973	.982	.983	.989	1.960	1.958	v.g.
May 5	3.9	4.4	1.468	.639	.737	.836	.880	.915	.961	.970	.981	.985	.985	1.957	1.957	g.+
7	4.2	9.8	1.418	.628	.728	.825	.871	.915	.955	.970	.979	.984	.989	1.956	1.958	v.g.
18	3.3	4.4	1.485	.651	.736	.836	.881	.917	.960	.973	.976	.986	.987	1.961	1.961	v.g.−
24	2.6	1.3	1.545	.631	.756	.841	.884	.924	.961	.969	.977	.983	.987	1.990	1.988	g.
June 3	2.5	3.4	1.491	.641	.729	.836	.879	.914	.965	.967	.981	.985	.985	1.962	1.962	v.g.−
14	3.9	3.5	1.497	.631	.750	.829	.879	.918	.964	.973	.983	.978	.986	1.960	1.960	v.g.−
19	2.1	0.4	1.580	------	.730	.841	.880	.927	.966	.978	.981	.983	.985	1.974	1.971	g.−
24	2.6	3.6	1.495	.628	.736	.829	.879	.913	.960	.975	.979	.986	.985	1.972	1.972	v.g.
28	2.5	1.5	1.532	.696	.750	.827	.884	.923	.960	.972	.978	.985	.981	1.956	1.954	g.
July 2	2.3	4.1	1.488	.625	.742	.834	.882	.920	.963	.976	.986	.987	.989	1.951	1.951	v.g.+
8	2.8	3.2	1.504	.666	.739	.836	.883	.906	.954	.975	.983	.985	.988	1.974	1.974	v.g.
12	2.1	1.7	1.535	.657	.739	.835	.875	.921	.963	.976	.986	.980	.982	1.981	1.979	v.g.
31	2.7	3.4	1.505	.640	.745	.833	.884	.916	.965	.972	.982	.987	.987	1.967	1.967	v.g.
Aug. 11	2.4	1.1	1.551	.650	.745	.831	.893	.912	.963	.974	.982	.982	.989	1.971	1.969	v.g.+
16	3.7	4.6	1.478	.631	.748	.830	.877	.914	.960	.974	.983	.983	.990	1.961	1.961	v.g.+
21	2.3	1.0	1.554	.634	.745	.830	.895	.909	.965	.977	.989	.984	.989	1.955	1.952	v.g.
26	2.9	1.5	1.544	.635	.751.	.835	.882	.916	.965	.978	.985	.987	.986	1.971	1.969	v.g.+
31	2.6	3.4	1.491	.635	.741	.832	.881	.915	.961	.970	.983	.982	.988	1.966	1.966	v.g.
Sept. 5	3.3	2.3	1.523	.636	.751	.836	.882	.915	.956	.973	.985	.986	.986	1.965	1.963	v.g.
10	3.3	4.2	1.448	.612	.730	.818	.866	.907	.949	.960	.970	.978	.984	1.985	1.985	v.g.−
26	4.5	6.2	1.460	.634	.738	.830	.879	.914	.963	.978	.984	.985	.987	1.954	1.955	v.g.+
Oct. 1	4.3	3.6	1.481	.631	.736	.826	.880	.914	.953	.968	.975	.978	.983	1.960	1.960	v.g.+
9	4.1	3.9	1.482	.634	.738	.830	.880	.910	.960	.969	.980	.980	.986	1.962	1.962	v.g.+
14	4.5	7.1	1.427	.625	.734	.816	.860	.896	.940	.956	.965	.966	.973	1.991	1.992	v.g.
23	3.4	3.5	1.497	.648	.748	.839	.886	.919	.961	.977	.987	.988	.985	1.946	1.946	v.g.
30	4.1	2.3	1.519	.626	.755	.841	.888	.921	.963	.979	.988	.985	.992	1.947	1.945	v.g.+
Nov. 9	3.1	2.8	1.507	.640	.746	.835	.885	.913	.965	.974	.984	.981	.985	1.954	1.952	v.g.+
14	4.4	7.4	1.437	.609	.731	.823	.875	.913	.957	.969	.982	.982	.985	1.973	1.974	v.g.+
19	4.1	4.8	1.479	.642	.750	.840	.886	.921	.965	.977	.985	.988	.987	1.958	1.958	v.g.+
26	4.6	6.1	1.403	.630	.736	.821	.869	.906	.947	.960	.968	.970	.977	1.944	1.944	v.g.
30	5.0	4.9	1.472	.637	.751	.840	.886	.915	.953	.972	.880	.983	.991	1.962	1.962	v.g.+
Dec. 5	4.5	4.1	1.490	.642	.746	.831	.883	.918	.956	.971	.979	.981	.985	1.964	1.964	v.g.
17	5.5	3.4	1.501	.633	.736	.830	.882	.914	.955	.964	.978	.980	.985	1.986	1.986	v.g.−

TABLE 29*a*.—*Solar-constant values. Long method. Harqua Hala, 1920–1925*

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.350 μ	38 0.398 μ	32 0.452 μ	28 0.502 μ	22 0.626 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ			
1920	*Mm*	*Mm*														
Oct. 4	------	7.0	1.42	0.614	0.647	0.830	0.865	0.925	0.951	0.962	0.970	0.975	0.995	1.946	-------	G.+
10	------	1.8	1.49	.644	.752	.824	.871	.920	.955	.964	.977	.975	.977	1.952	1.956	v.g.−
14	------	3.0	1.45	.664	.711	.828	.871	.918	.970	.975	.991	.973	.991	1.931	1.938	g.+
15	------	3.5	1.46	.646	.733	.828	.865	.925	.959	.973	.977	.977	.999	1.954	1.964	v.g.−
16	------	5.3	1.42	.622	.745	.815	.879	.914	.964	.970	.982	.980	.991	1.933	1.947	v.g.−
22	------	4.4	1.44	.631	.743	.843	.877	.920	.959	.966	.975	.970	.984	1.912	1.923	g.+
26	------	3.0	1.45	.650	.716	.824	.889	.920	.968	.975	.986	.982	.980	1.932	1.940	v.g.
															1.945	
Nov. 2	------	2.4	1.15	.611	.724	.824	.865	.916	.959	.982	.984	.977	.982	1.921	1.926	v.g.
3	------	1.0	1.50	.650	.726	.832	.879	.925	.964	.977	.989	.989	.993	1.928	1.927	v.g.−
8	------	1.9	1.49	.670	.771	.834	.873	.925	.966	.977	.984	.982	.998	1.916	1.925	v.g.−
10	------	4.3	1.45	.635	.728	.832	.881	.925	.966	.977	.989	.980	.986	1.924	1.938	v.g.+
18	------	4.0	1.44	.662	.741	.840	.875	.929	.962	.970	.977	.977	.982	1.918	-------	v.g.
21	------	5.0	-------	.667	.800	.847	.867	.925	.962	.970	.984	.975	.989	1.896	(1.908)	g.−
															1.929	
Dec. 28	------	4.0	1.46	.655	.734	.836	.883	.927	.964	.973	.991	.991	.995	1.916	1.928	v.g.
30	------	6.5	1.43	.646	.716	.841	.881	.927	.959	.975	.984	.982	.999	1.924	1.942	g.−
31	------	4.0	1.44	.637	.741	.824	.885	.927	.962	.977	.984	.977	.986	1.927	1.940	v.g.+
															1.937	
1921																
Jan. 1	------	2.2	1.48	.634	.724	.832	.867	.914	.964	.975	.986	.986	.991	1.942	1.950	v.g.+
7	------	1.0	1.51	.658	.719	.798	.857	.920	.953	.973	.980	.977	.991	1.960	-------	g.
8	------	1.2	1.50	.665	.724	.834	.879	.925	.966	.977	.982	.989	.993	1.930	-------	v.g.
10	------	1.3	1.50	.635	.731	.828	.877	.927	.964	.980	.991	.989	.986	1.909	-------	v.g.+
14	------	3.0	1.47	.664	.730	.830	.879	.925	.962	.975	.980	.980	.989	1.943	1.955	g.+
19	------	2.3	1.47	.635	.753	.828	.873	.918	.962	.977	.984	.984	.986	1.920	-------	v.g.+
24	------	3.0	1.45	.625	.736	.830	.871	.918	.955	.968	.977	.975	.984	1.937	1.948	v.g.+
29	------	2.5	1.45	.625	.732	.823	.873	.913	.955	.970	.980	.982	.980	1.921	1.943	v.g.+
															1.949	
Feb. 1	------	5.0	1.41	.628	.745	.827	.876	.922	.958	.970	.978	.973	.984	1.899	1.917	g.
2	------	1.1	1.52	.639	.747	.833	.883	.924	.962	.979	.990	.987	.983	1.929	1.935	v.g.+
8	------	3.5	1.44	.635	.714	.824	.863	.906	.948	.963	.977	.975	.985	1.949	1.963	v.g.
11	------	7.0	1.43	.650	.736	.832	.876	.916	.960	.974	.885	.983	.985	1.931	1.950	v.g.+
12	------	4.5	1.45	.630	.723	.820	.871	.922	.958	.977	.987	.981	.989	1.953	(1.969)	v.g.+
13	------	3.5	1.46	.642	.726	.834	.877	.928	.965	.977	.985	.984	.990	1.914	1.929	v.g.
15	------	1.2	1.51	.620	.718	.825	.861	.922	.957	.972	.983	.988	.979	1.961	-------	v.g.
16	------	1.0	1.50	.642	.719	.822	.864	.908	.955	.968	.981	.971	.984	1.961	1.962	g.+
17	------	1.2	1.49	.655	.726	.829	.876	.919	.962	.974	.985	.988	.984	1.901	(1.902)	e.−
18	------	1.5	1.48	.644	.723	.828	.867	.912	.956	.972	.984	.978	.987	1.930	1.935	e.−
19	------	4.0	1.41	.620	.706	.806	.854	.997	.938	.954	.969	.962	.980	1.942	1.951	v.g.+
22	------	2.2	1.46	.633	.738	.825	.867	.914	.958	.977	.986	.981	.983	1.921	1.931	v.g.
23	------	4.0	1.45	.631	.730	.823	.868	.924	.958	.977	.985	.981	.983	1.938	1.952	v.g.
24	------	5.0	1.44	.645	.738	.829	.876	.917	.959	.974	.987	.985	.990	1.914	1.931	e.−
25	------	5.0	1.43	.642	.721	.812	.862	.912	.955	.972	.978	.972	.979	1.939	1.955	v.g.+
															1.943	
Mar. 2	------	5.0	1.406	.633	.731	.823	.869	.909	.956	.967	.980	.980	.986	1.921	1.938	v.g.
16	------	4.0	1.291	.635	.741	.827	.867	.909	.958	.970	.982	.978	.990	1.941	1.954	v.g.+
17	------	7.0	1.362	.618	.707	.804	.850	.901	.949	.963	.977	.973	.976	1.936	1.952	e.−
27	------	2.0	1.316	.609	.696	.775	.827	.867	.909	.928	.941	.942	.958	1.913	1.910	v.g.−
28	------	4.0	1.225	.595	.680	.758	.810	.843	.889	.911	.924	.926	.949	1.930	1.931	g.−
29	------	3.5	1.337	.612	.716	.789	.836	.869	.915	.930	.943	.946	.958	1.956	1.957	v.g.+
31	------	4.5	1.211	.581	.675	.756	.792	.834	.880	.895	.908	.912	.928	1.963	1.961	g.
															1.943	

TABLE 29a.—*Solar-constant values. Long method. Harqua Hala, 1920–1925*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46 (0.350 μ)	38 (0.398 μ)	32 (0.452 μ)	28 (0.502 μ)	22 (0.626 μ)	19 (0.724 μ)	17 (0.817 μ)	14 (0.994 μ)	11 (1.225 μ)	6 (1.600 μ)	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1921	*Mm*	*Mm*														
Apr. 6	------	2.2	1.339	0.617	0.714	0.802	0.837	0.871	0.923	0.942	0.952	0.947	0.972	1.936	1.933	g.−
10	------	2.0	1.346	.608	.677	.777	.818	.864	.916	.928	.940	.952	.964	1.966	1.962	e.−
11	------	2.5	1.333	.620	.716	.811	.849	.896	.941	.952	.961	.961	.971	1.918	1.919	v.g.+
15	------	2.0	1.384	.640	.698	.800	.838	.888	.934	.947	.960	.968	.963	1.940	1.939	v.g.−
17	------	2.6	1.323	.607	.706	.794	.836	.878	.927	.938	.954	.957	.972	1.932	1.929	e.−
18	------	------	1.365	.626	.707	.783	.829	.880	.922	.937	.948	.948	.962	1.952	------	e.
20	2.0	3.1	1.293	.622	.698	.794	.828	.877	.918	.933	.943	.943	.961	1.959	1.959	e.−
															1.940	
May 13	3.5	6.2	1.352	.611	.728	.800	.838	.893	.936	.947	.951	.953	.975	1.957	1.970	v.g.+
18	3.4	4.2	1.343	.608	.703	.782	.808	.881	.952	.962	.971	.970	.972	1.969	1.975	v.g.
19	4.1	2.5	1.425	.643	.747	.830	.852	.914	.961	.966	.985	.982	.986	1.910	1.915	v.g.+
25	10.5	7.3	1.383	.642	.725	.819	.859	.908	.958	.967	.972	.974	.977	1.950	1.970	v.g.+
															1.954	
June 7	6.1	11.5	1.325	.618	.711	.806	.847	.898	.942	.952	.962	.955	.966	1.919	1.937	v.g.+
15	5.2	------	1.401	.632	.717	.815	.861	.903	.948	.962	.969	.966	.981	1.932	------	v.g.+
17	2.9	1.7	1.453	.634	.722	.818	.860	.897	.956	.967	.976	.970	.983	1.935	1.937	e.−
21	3.4	7.3	1.382	.631	.724	.817	.858	.907	.953	.963	.969	.964	.978	1.934	1.950	e.
25	3.3	3.5	1.425	.652	.742	.833	.877	.922	.957	.972	.978	.979	.982	1.910	1.922	e.
27	2.8	3.8	1.405	.627	.721	.817	.857	.913	.958	.967	.981	.972	.986	1.924	1.937	e.−
															1.937	
July 1	6.4	11.0	1.327	.626	.720	.806	.850	.902	.946	.958	.967	.957	.970	1.914	1.933	e.
															1.933	
Aug. 30	10.4	17.5	1.308	.624	.697	.788	.837	.893	.937	.951	.972	.958	.979	1.917	1.941	e.
31	11.3	23.7	1.314	.633	.724	.824	.855	.902	.944	.958	.966	.955	.976	1.899	1.923	v.g.
															1.932	
Sept. 1	9.3	9.5	1.374	.636	.727	.816	.857	.904	.942	.957	.968	.958	.972	1.938	1.960	e.
3	6.2	6.5	1.418	.643	.733	.822	.864	.911	.954	.965	.973	.963	.975	1.950	1.969	e.−
5	5.6	6.5	1.405	.646	.729	.823	.860	.911	.947	.963	.971	.958	.976	1.954	1.975	e.−
6	5.1	7.0	1.394	.641	.732	.820	.863	.913	.952	.963	.975	.964	.975	1.931	1.953	e.
7	5.1	5.0	1.429	.639	.732	.818	.868	.919	.954	.961	.981	.969	.978	1.945	1.961	e.
10	7.8	2.0	1.433	.621	.737	.812	.862	.914	.957	.969	.981	.969	.981	1.942	1.951	v.g.
14	5.6	6.0	1.419	.648	.749	.838	.877	.923	.959	.970	.986	.976	.983	1.913	1.931	e.
17	4.7	3.0	1.435	.636	.742	.819	.865	.916	.956	.969	.980	.977	.986	1.926	1.938	e.−
19	6.0	5.0	1.387	.619	.728	.816	.861	.907	.948	.961	.973	.967	.979	1.911	1.923	e.−
20	7.9	5.5	1.416	.639	.737	.828	.867	.913	.958	.972	.981	.971	.986	1.919	1.949	e.
24	8.1	13.0	1.347	.630	.733	.823	.863	.913	.952	.967	.980	.972	.979	1.901	1.927	e.
26	8.3	10.0	1.378	.633	.728	.819	.868	.917	.956	.965	.977	.967	.981	1.917	1.941	e.
27	6.5	9.0	1.373	.623	.725	.822	.864	.913	.954	.965	.980	.967	.980	1.908	1.930	e.−
															1.947	
Oct. 3	9.8	8.5	1.366	.623	.732	.816	.871	.916	.960	.971	.977	.963	.975	1.917	1.937	v.g.−
4	9.3	12.5	1.368	.620	.744	.837	.872	.921	.962	.969	.976	.964	.985	1.898	------	v.g.−
7	8.0	7.0	1.413	.629	.737	.830	.871	.920	.957	.967	.977	.969	.975	1.936	1.955	e.−
9	8.4	10.6	1.328	.622	.708	.794	.843	.896	.940	.943	.957	.954	.965	1.931	1.949	v.g.+
10	6.7	6.0	1.417	.640	.738	.839	.873	.923	.961	.968	.980	.968	.980	1.919	1.937	v.g.+
15	6.3	10.6	1.366	.624	.728	.816	.856	.912	.955	.967	.973	.967	.982	1.916	1.940	e.−
19	5.7	5.2	1.424	.645	.745	.823	.864	.918	.960	.968	.977	.972	.980	1.932	1.949	e.−
21	5.2	8.7	1.373	.635	.720	.807	.848	.903	.938	.948	.961	.956	.967	1.961	1.982	v.g.
26	4.6	2.8	1.450	.637	.747	.829	.870	.917	.962	.962	.971	.960	.974	1.941	1.953	v.g.−
27	4.2	3.6	1.447	.637	.746	.823	.870	.920	.962	.972	.979	.978	.977	1.926	1.941	v.g.−
29	4.2	2.3	1.477	.667	.743	.832	.878	.928	.964	.968	.979	.974	.981	1.943	1.952	e.−
															1.949	

TABLE 29*a*.—*Solar-constant values. Long method. Harqua Hala, 1920–1925*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.350 μ	38 0.398 μ	32 0.452 μ	28 0.502 μ	22 0.626 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ			
1921	*Mm*	*Mm*														
Nov. 2	4.1	2.3	1.463	0.645	0.744	0.823	0.873	0.923	0.957	0.972	0.976	0.975	0.982	1.937	1.946	e.−
10	3.3	2.2	1.472	.632	.748	.831	.872	.917	.958	.976	.982	.970	.982	1.946	1.955	v.g.+
14	3.0	5.3	1.442	.646	.745	.843	.873	.925	.963	.973	.984	.976	.980	1.949	1.965	v.g.+
15	3.5	7.6	1.407	.643	.752	.822	.868	.915	.961	.970	.981	.972	.981	1.930	1.950	v.g.+
21	3.0	2.2	1.497	.669	.753	.835	.876	.929	.966	.981	.989	.977	.986	1.912	1.919	v.g.+
															1.947	
Dec. 7	4.1	2.9	1.455	.641	.735	.826	.868	.917	.957	.968	.979	.971	.980	1.946	1.957	v.g.
8	2.9	1.6	1.489	.659	.733	.830	.872	.915	.966	.971	.978	.982	.986	1.936	1.942	e.
9	1.8	0.9	1.530	.645	.745	.832	.875	.917	.963	.977	.980	.982	.982	1.954	1.957	e.
15	6.7	10.0	1.400	.658	.745	.835	.878	.922	.961	.980	.986	.980	.986	1.902	1.923	e.−
															1.945	
1922																
Jan. 13	1.5	1.2	1.504	.664	.740	.827	.868	.918	.960	.972	.981	.972	.982	1.945	1.959	e.
14	2.2	1.1	1.507	.661	.748	.824	.869	.918	.962	.976	.985	.982	.987	1.937	1.942	e.
15	2.1	1.8	1.517	.654	.747	.838	.875	.917	.962	.977	.987	.982	.985	1.912	1.920	e.
16	2.3	2.9	1.458	.648	.742	.833	.871	.926	.964	.978	.983	.976	.983	1.920	1.931	e.
20	1.8	1.3	1.485	.664	.732	.828	.862	.915	.959	.958	.973	.978	.975	1.942	1.948	v.g.+
21	1.8	1.1	1.487	.658	.739	.828	.867	.915	.957	.970	.981	.981	.978	1.935	1.941	e.−
26	1.5	1.9	1.451	.635	.732	.810	.848	.906	.943	.962	.969	.969	.980	1.951	1.955	e.−
															1.942	
Feb. 2	2.6	1.4	1.484	.655	.745	.828	.868	.918	.957	.970	.980	.982	.983	1.913	1.921	e.
6	1.9	2.1	1.478	.650	.740	.830	.868	.922	.962	.972	.977	.972	.978	1.965	1.973	e.
13	2.9	1.8	1.486	.648	.747	.837	.875	.915	.960	.979	.981	.977	.984	1.947	1.954	e.
															1.949	
Mar. 1	2.0	1.5	1.439	.630	.719	.822	.849	.898	.955	.964	.968	.958	.972	1.921	1.922	v.g.−
2	2.2	1.2	1.480	.665	.730	.820	.861	.909	.950	.967	.977	.975	.981	1.935	1.936	e.
10	1.8	1.9	1.401	.646	.727	.816	.850	.900	.938	.951	.961	.957	.971	1.941	1.942	v.g.+
18	3.9	1.9	1.468	.645	.733	.834	.862	.902	.948	.965	.979	.979	.986	1.963	1.972	v.g.
															1.943	
Apr. 3	4.7	4.9	1.388	.628	.715	.812	.851	.900	.948	.961	.973	.962	.977	1.913	1.927	e.−
8	4.2	6.0	1.337	.607	.700	.791	.837	.887	.940	.941	.961	.961	.963	1.902	1.916	v.g.+
15	2.9	6.0	1.373	.616	.712	.806	.844	.878	.942	.948	.968	.967	.972	1.928	1.945	v.g.
24	3.2	2.8	1.389	.608	.692	.782	.831	.878	.928	.945	.960	.958	.970	1.940	1.947	e.−
27	5.4	8.5	1.197	.580	.637	.734	.777	.844	.897	.907	.975	.927	.947	1.895	1.904	v.g.
															1.944	
May 2	2.5	5.7	1.324	.617	.695	.792	.824	.880	.927	.941	.954	.953	.966	1.907	1.917	e.−
5	3.9	3.6	------	.608	.706	.785	.827	.873	.923	.935	.946	.944	.962	1.904	------	v.g.
11	3.7	3.7	1.357	.623	.712	.792	.830	.883	.928	.942	.958	.942	.963	1.921	1.925	e.−
22	2.9	3.9	1.463	.649	.730	.820	.862	.909	.950	.959	.972	.968	.974	1.901	1.911	e.
31	3.4	6.3	1.355	.630	.702	.790	.833	.888	.932	.948	.963	.962	.971	1.924	1.938	e.
															1.922	
June 3	3.9	3.2	1.442	.645	.730	.836	.866	.911	.952	.960	.980	.972	.972	1.922	1.935	e.
6	3.7	2.7	1.458	.663	.756	.846	.878	.925	.964	.976	.987	.974	.984	1.892	1.902	e.
10	1.2	1.5	1.484	.662	.749	.837	.881	.922	.965	.977	.986	.984	.982	1.903	1.909	e.−
15	4.8	6.5	1.368	.637	.727	.813	.859	.899	.951	.963	.975	.967	.973	1.896	1.914	e.
17	4.1	5.4	1.380	.637	.731	.825	.866	.917	.956	.968	.977	.970	.979	1.881	1.900	e.
															1.910	

TABLE 29a.—*Solar-constant values. Long method. Harqua Hala, 1920–1925*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46 0.350 μ	38 0.398 μ	32 0.452 μ	28 0.502 μ	22 0.626 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1922	*Mm*	*Mm*														
July 8	8.6	12.7	1.238	0.591	0.634	0.751	0.793	0.853	0.911	0.929	0.944	0.936	0.951	1.945	1.962	v.g.+
14	7.9	13.1	1.277	.602	.692	.782	.826	.876	.923	.938	.952	.948	.952	1.934	1.953	v.g.+
															1.957	
Aug. 3	9.7	14.2	1.265	.606	.678	.773	.828	.886	.927	.942	.957	.953	.958	1.902	1.923	e.−
															1.923	
Sept. 14	8.0	11.9	1.285	.600	.689	.792	.838	.902	.939	.955	.972	.960	.973	1.872	1.892	e.−
19	6.7	11.2	1.217	.557	.621	.725	.782	.850	.915	.933	.952	.946	.960	1.914	1.930	v.g.
25	6.0	13.0	1.250	.621	.675	.746	.810	.871	.926	.943	.965	.962	.963	1.913	1.932	v.g.
29	4.6	2.4	1.465	.673	.750	.845	.883	.923	.966	.973	.984	.971	.984	1.907	1.918	v.g.
															1.927	
Oct. 5	5.8	9.1	1.390	.644	.734	.833	.870	.922	.961	.977	.982	.985	.977	1.909	1.929	v.g.
10	5.1	7.5	1.418	.659	.747	.832	.879	.922	.964	.972	.982	.977	.987	1.915	1.924	v.g.+
14	4.4	7.2	1.378	.655	.722	.798	.842	.891	.943	.954	.976	.976	.978	1.933	1.941	v.g.−
29	3.1	3.0	-------	.634	.733	.825	.867	.910	.950	.962	.976	.971	.976	1.898	-------	p.+
															1.931	
Nov. 2	3.3	1.8	-------	.670	.757	.818	.866	.918	.966	.974	.980	.978	.985	1.927	-------	v.g.
4	1.8	3.0	1.428	.656	.708	.835	.855	.895	.964	.976	.984	.972	.981	1.902	1.912	g.−
19	3.2	2.3	1.462	.695	.765	.846	.879	.935	.970	.972	.982	.975	.987	1.894	1.903	e.
23	4.5	5.4	1.385	.625	.700	.805	.838	.883	.950	.958	.966	.960	.976	1.936	1.950	v.g.−
															1.922	
Dec. 2	5.1	8.6	1.400	.662	.754	.840	.870	.916	.967	.974	.982	.975	.977	1.910	1.930	v.g.−
16	5.1	5.9	1.425	.675	.745	.840	.872	.909	.963	.974	.984	.984	.987	1.902	1.920	v.g.+
18	3.3	3.1	1.462	.664	.748	.841	.875	.925	.968	.981	.991	.990	.991	1.910	1.920	v.g.
23	2.8	2.5	1.472	.645	.739	.835	.870	.930	.967	.977	.985	.978	.983	1.913	1.921	e.−
															1.923	
1923																
Jan. 1	2.9	2.5	1.473	.663	.752	.853	.872	.915	.953	.970	.970	.962	.980	1.898	1.908	v.g.−
9	2.3	2.7	1.477	.667	.747	.838	.877	.915	.967	.978	.988	.983	.990	1.904	1.913	e.
12	2.2	1.7	1.493	.676	.750	.845	.882	.929	.968	.979	.987	.979	.990	1.903	1.907	e.
16	3.4	6.0	1.413	.656	.735	.829	.875	.907	.960	.972	.986	.978	.981	1.905	1.924	e.−
20	4.0	6.7	1.394	.672	.732	.827	.862	.906	.955	.967	.976	.972	.983	1.908	1.929	e.
															1.916	
Feb. 5	1.9	2.4	1.463	.622	.749	.830	.878	.928	.966	.968	.986	.985	.983	1.899	1.908	v.g.+
16	5.3	7.3	1.357	.648	.718	.815	.842	.894	.937	.944	.958	.962	.972	1.926	1.940	e.−
23	5.4	7.2	1.328	.604	.651	.761	.820	.876	.930	.949	.965	.966	.975	1.939	1.954	e.−
															1.934	
Mar. 15	1.6	0.8	1.491	.655	.724	.807	.853	.911	.951	.965	.974	.967	.982	1.958	1.958	v.g.
22	1.7	2.4	1.410	.660	.732	.821	.860	.905	.950	.961	.975	.969	.976	1.911	1.914	e.−
26	2.1	0.9	1.495	.670	.747	.834	.875	.916	.967	.975	.982	.981	.990	1.907	1.911	e.−
30	3.5	7.3	1.240	.560	.627	.733	.791	.860	.911	.932	.945	.952	.962	1.909	1.920	v.g.+
															1.926	
Apr. 8	2.9	2.0	1.417	.642	.724	.825	.866	.910	.952	.962	.976	.970	.980	1.901	1.904	e.
23	2.5	2.4	1.429	.650	.734	.821	.866	.908	.957	.971	.982	.980	.985	1.906	1.912	v.g.+
28	4.1	5.3	1.388	.622	.698	.793	.834	.885	.932	.951	.963	.961	.969	1.961	1.973	v.g.
															1.908	

Table 29a.—*Solar-constant values. Long method. Harqua Hala, 1920–1925*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths: Place and wave length										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				46 0.350 μ	38 0.398 μ	32 0.452 μ	28 0.502 μ	22 0.626 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ			
1923	*Mm*	*Mm*														
May 3	3.4	4.4	1.429	0.643	0.745	0.838	0.870	0.915	0.964	0.976	0.980	0.976	0.983	1.919	1.935	v.g.
10	4.1	6.9	1.313	.622	.702	.792	.834	.879	.932	.945	.957	.959	.973	1.912	1.925	v.g.
15	3.9	7.7	1.395	.669	.743	.825	.875	.916	.961	.970	.981	.977	.981	1.922	1.943	v.g.+
19	4.8	5.4	1.333	.639	.696	.785	.839	.881	.935	.952	.970	.970	.977	1.901	1.913	v.g.+
24	4.5	6.0	1.304	.636	.694	.795	.834	.879	.921	.935	.947	.946	.959	1.916	1.924	v.g.
31	1.3	1.7	1.457	.665	.751	.825	.875	.920	.962	.979	.986	.975	.982	1.925	1.933	v.g.
															1.929	
June 6	3.3	6.2	1.396	.660	.744	.840	.876	.916	.960	.971	.980	.975	.984	1.908	1.928	e.
21	5.2	4.7	1.329	.632	.681	.771	.821	.886	.928	.949	.963	.967	.979	1.935	1.945	e.
28	2.7	2.3	1.447	.667	.757	.834	.879	.917	.959	.970	.987	.982	.989	1.903	1.913	e.
															1.929	
Aug. 4	8.2	15.3	1.312	.620	.700	.803	.841	.885	.928	.949	.958	.962	.962	1.966	(1.989)	e.
14	9.1	13.8	1.312	.620	.686	.791	.831	.886	.934	.950	.961	.961	.967	1.951	1.972	v.g.
21	7.1	11.9	1.342	.636	.715	.825	.859	.894	.936	.948	.960	.960	.966	1.918	1.939	g.
															1.950	
Sept. 20	6.8	3.9	1.435	.630	.725	.820	.880	.920	.961	.965	.980	.975	.979	1.913	1.926	v.g.
28	4.6	4.2	1.423	.670	.715	.820	.875	.925	.960	.971	.970	.960	.978	1.912	1.926	v.g.
															1.926	
Oct. 5	9.6	6.2	1.411	.615	.739	.830	.876	.918	.946	.972	.975	.974	.976	1.915	1.934	e.
12	10.5	6.5	1.428	.654	.736	.840	.871	.920	.970	.971	.978	.985	.982	1.931	1.948	v.g.
22	9.6	4.9	1.440	.663	.730	.821	.866	.925	.955	.970	.985	.989	.990	1.937	1.954	v.g.
															1.945	
Nov. 13	5.9	2.7	1.481	.660	.740	.828	.874	.921	.965	.981	.992	.986	.990	1.936	1.945	e.
															1.945	
Dec. 6	3.2	2.5	1.505	.660	.746	.833	.874	.915	.960	.972	.986	.980	.989	1.948	1.956	e.
16	3.7	4.7	1.433	.686	.740	.832	.868	.918	.954	.964	.979	.976	.981	1.931	1.946	e.
															1.951	
1924																
Jan. 4	2.2	0.5	1.540	.687	.755	.851	.885	.913	.969	.978	.989	.989	.990	1.925	1.923	v.g.+
11	2.9	2.9	1.471	.686	.740	.835	.880	.920	.965	.982	.988	.982	.986	1.911	1.920	v.g.
19	1.7	0.8	1.512	.661	.731	.832	.867	.911	952	.970	.982	.982	.984	1.949	1.940	v.g.
29	3.7	4.6	1.443	.674	.737	.838	.878	.908	.960	.973	.990	.982	.989	1.907	1.922	e.
															1.926	
Feb. 12	2.0	1.3	1.503	.690	.753	.828	.868	.910	.956	.969	.980	.980	.985	1.955	1.959	e.
19	2.3	1.5	1.497	.655	.730	.825	.865	.915	.960	.977	.989	.985	.990	1.956	1.961	v.g.+
27	2.3	1.8	1.470	.666	.738	.823	.865	.905	.955	.970	.971	.980	.969	1.899	1.907	v.g.
															1.942	
Mar. 26	4.1	3.1	1.439	.640	.719	.816	.860	.908	.949	.966	.981	.977	.987	1.939	1.950	e.
															1.950	
Apr. 12	6.0	8.1	1.336	.633	.700	.796	.835	.878	.931	.948	.965	.967	.978	1.924	1.941	e.
															1.941	
May 1	4.0	7.6	1.262	.610	.667	.757	.807	.871	.912	.929	.948	.948	.962	1.905	1.918	e.
22	3.8	2.8	1.472	.662	.749	.832	.874	.917	.957	.972	.981	.980	.986	1.940	1.949	e.
															1.933	

TABLE 29*a*.—*Solar-constant values. Long method. Harqua Hala, 1920–1925*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0. 350 μ	38 0. 398 μ	32 0. 452 μ	28 0. 502 μ	22 0. 626 μ	19 0. 724 μ	17 0. 817 μ	14 0. 994 μ	11 1. 225 μ	6 1. 600 μ			
1924	*Mm*	*Mm*														
June 15	4. 6	8. 9	1. 347	0. 652	0. 702	0. 801	0. 845	0. 890	0. 936	0. 958	0. 970	0. 972	0. 972	1. 922	1. 941	e.—
19	3. 4	2. 7	1. 419	. 677	. 741	. 816	. 869	. 909	. 938	. 957	. 966	. 966	. 963	1. 923	1. 930	v.g.+
20	3. 2	2. 4	1. 441	. 644	. 715	. 812	. 850	. 895	. 943	. 955	. 969	. 968	. 972	1. 964	1. 970	e.
21	4. 3	3. 4	1. 444	. 664	. 735	. 837	. 870	. 914	. 954	. 965	. 977	. 973	. 974	-------	1. 945	e.
25	9. 3	11. 5	1. 336	. 644	. 702	. 816	. 852	. 902	. 942	. 952	. 966	. 974	. 975	1. 912	1. 934	e.
															1. 944	
July 17	8. 7	10. 5	1. 361	. 656	. 729	. 817	. 862	. 915	. 957	. 968	. 982	. 976	. 985	1. 897	1. 922	e.
19	5. 2	8. 5	1. 399	. 642	. 727	. 825	. 862	. 913	. 952	. 962	. 973	. 970	. 982	1. 946	1. 966	e.
20	6. 1	7. 0	1. 411	. 650	. 732	. 828	. 870	. 915	. 955	. 969	. 977	. 977	. 983	1. 935	1. 954	e. —
21	6. 9	6. 3	1. 410	. 652	. 734	. 826	. 862	. 908	. 951	. 960	. 973	. 967	. 975	1. 946	1. 965	e.
															1. 952	
Aug. 27	10. 4	15. 3	1. 273	. 600	. 657	. 755	. 805	. 882	. 926	. 940	. 963	. 966	. 977	1. 936	1. 955	e.
															1. 955	
Sept. 11	6. 1	7. 3	1. 382	. 615	. 704	. 787	. 838	. 895	. 937	. 951	. 965	. 965	. 972	1. 965	1. 985	e. —
19	6. 9	5. 8	1. 329	. 609	. 681	. 789	. 829	. 876	. 918	. 934	. 948	. 943	. 962	1. 959	1. 970	v.g.
24	6. 5	7. 0	1. 423	. 649	. 741	. 828	. 877	. 923	. 962	. 974	. 980	. 982	. 986	1. 930	1. 948	e.
															1. 959	
Oct. 3	2. 3	3. 9	1. 414	. 668	. 747	. 822	. 869	. 909	. 952	. 967	. 973	. 967	. 972	1. 915	1. 924	e.
8	4. 8	6. 0	1. 432	. 647	. 751	. 836	. 873	. 920	. 960	. 973	. 986	. 972	. 981	1. 942	1. 958	e. —
15	2. 8	1. 9	1. 504	. 650	. 750	. 833	. 878	. 931	. 962	. 974	. 982	. 980	. 987	1. 948	1. 953	e.—
21	3. 9	3. 6	1. 468	. 651	. 744	. 326	. 871	. 922	. 960	. 975	. 986	. 979	. 985	1. 945	1. 956	e.
31	2. 7	2. 5	1. 490	. 646	. 748	. 817	. 877	. 918	. 962	. 971	. 986	. 988	. 987	1. 962	1. 970	v.g.+
															1. 952	
Nov. 7	2. 8	1. 5	1. 490	. 659	. 739	. 840	. 875	. 931	. 965	. 975	. 987	. 987	. 986	1. 930	1. 935	e.—
18	4. 8	3. 4	1. 474	. 664	. 742	. 838	. 875	. 927	. 965	. 975	. 987	. 987	. 983	1. 928	1. 939	e.
24	2. 3	0. 5	1. 538	. 671	. 747	. 832	. 875	. 924	. 963	. 979	. 985	. 984	. 980	1. 962	1. 960	v.g.+
															1. 945	
Dec. 3	3. 2	1. 4	1. 498	. 659	. 743	. 836	. 881	. 920	. 960	. 977	. 983	. 977	. 982	1. 961	1. 964	e.
29	3. 3	3. 0	1. 476	. 678	. 740	. 840	. 880	. 930	. 972	. 979	. 990	. 992	. 994	1. 915	1. 913	e.
															1. 939	
1925																
Jan. 5	2. 4	3. 5	1. 456	. 645	. 720	. 821	. 870	. 918	. 962	. 976	. 995	. 984	. 994	1. 928	1. 939	e.
14	2. 9	2. 7	1. 474	. 680	. 736	. 819	. 872	. 920	. 960	. 973	. 985	. 982	. 987	-------	1. 967	e.
20	3. 5	1. 3	1. 506	. 670	. 733	. 838	. 874	. 911	. 960	. 974	. 982	. 981	. 988	1. 957	1. 959	e. —
30	4. 2	1. 5	1. 499	. 674	. 740	. 825	. 872	. 915	. 957	. 971	. 982	. 982	. 984	1. 962	1. 970	e.
															1. 959	
Mar. 19	1. 5	1. 7	1. 467	. 650	. 742	. 823	. 860	. 912	. 950	. 960	. 970	. 972	. 982	1. 968	1. 974	v.g.+
															1. 974	
Apr. 20	3. 1	3. 6	1. 446	. 652	. 738	. 828	. 870	. 908	. 952	. 965	. 978	. 970	. 980	1. 950	1. 964	v.g.+
25	3. 5	2. 4	1. 421	. 627	. 682	. 784	. 832	. 884	. 937	. 956	. 967	. 968	. 981	1. 966	1. 974	e.—
															1. 969	
May 2	5. 0	7. 8	1. 313	. 617	. 689	. 781	. 825	. 883	. 928	. 944	. 956	. 959	. 961	1. 922	1. 936	v.g.+
28	4. 6	7. 2	1. 332	. 615	. 677	. 785	. 822	. 875	927	. 940	. 955	. 953	. 959	1. 939	1. 952	v.g.+
															1. 944	
June 10	2. 5	3. 6	1. 438	. 666	. 731	. 822	. 865	. 914	. 952	. 967	. 979	. 977	. 979	1. 914	1. 926	e.
															1. 926	

TABLE 29b.—*Solar-constant values. Long method. Table Mountain, 1925–1930*

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				46 0.348 μ	38 0.391 μ	32 0.446 μ	28 0.497 μ	22 0.615 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ			
1925	*Mm*	*Mm*														
Dec. 6	------	5.2	1.463	0.658	0.740	0.809	0.881	0.920	0.962	0.976	0.983	0.982	0.992	1.939	1.940	e.
7	3.0	2.5	1.498	.655	.750	.832	.892	.927	.972	.980	.985	.978	.992	1.905	1.906	e.
9	2.9	3.6	1.481	.651	.745	.836	.885	.923	.970	.980	.982	.982	.990	1.920	1.921	e.
10	2.8	3.1	1.475	.666	.749	.828	.888	.923	.971	.982	.991	.987	.994	1.892	1.893	e.
11	1.7	3.6	-------	.656	.745	.835	.881	.919	.972	.980	.989	.987	.994	1.905	1.906	e.
13	2.1	1.5	1.503	.665	.745	.823	.882	.918	.974	.979	.985	.978	.990	1.888	1.888	e.
14	1.3	1.2	1.526	.640	.754	.823	.887	.926	.968	.974	.985	.980	.987	1.912	1.912	v.g.
16	2.8	5.1	1.458	.646	.752	.832	.880	.931	.975	.982	.989	.986	.992	1.885	1.886	v.g.−
26	1.9	2.9	1.496	.616	.752	.840	.885	.921	.970	.973	.982	.983	.992	1.930	1.931	v.g.+
1926																
Jan. 2	4.5	6.0	-------	.636	.749	.833	.880	.917	.975	.984	.984	.977	.984	1.889	1.889	v.g.+
4	1.8	2.6	1.478	.637	.737	.827	.868	.912	.967	.971	.982	.976	.985	1.944	1.945	e.−
5	2.2	4.6	1.466	.655	.746	.833	.883	.928	.972	.978	.986	.982	.992	1.895	1.896	e.
7	2.0	2.9	1.483	.620	.732	.826	.878	.980	.966	.972	.986	.984	.990	1.925	1.926	e.−
8	2.1	2.2	1.508	.649	.738	.828	.885	.922	.968	.979	.987	.981	.991	1.900	1.901	v.g.+
9	1.8	2.0	1.502	.663	.747	.841	.882	.929	.969	.980	.987	.982	.991	1.890	1.891	e.−
11	1.7	2.7	1.493	.631	.744	.822	.877	.926	.962	.970	.982	.982	.990	1.938	1.939	v.g.+
12	1.9	1.5	1.510	.656	.754	.837	.888	.901	.968	.979	.989	990	987	1.894	1.894	v.g.+
14	1.1	2.2	-------	.637	.730	.824	.875	.909	.961	.973	.983	.977	.986	1.944	1.945	e.
18	1.2	1.4	1.504	.627	.750	.828	.877	.917	.968	.978	.987	.987	.987	1.908	1.908	e.
21	1.3	2.7	1.458	.642	.732	.832	.873	.905	.962	.972	.982	.978	.982	1.906	1.907	e.
23	1.2	2.8	1.466	.639	.741	.840	.867	.910	.972	.977	.986	.982	.985	1.906	1.907	e.
25	2.1	1.3	1.506	.638	.741	.833	.874	.912	.965	.977	.987	.982	.986	1.914	1.914	e.−
26	1.7	0.7	1.525	.636	.735	.830	.875	.912	.968	.970	.985	.977	.988	1.917	1.917	v.g.
27	0.4	0.6	1.549	.640	.748	.827	.879	.915	.965	.972	.987	.972	.986	1.934	1.934	e.−
28	0.7	3.4	1.470	.623	.746	.836	.887	.923	.968	.974	.984	.977	.992	1.904	1.905	e.
Feb. 3	2.9	5.9	1.440	.653	.755	.842	.883	.917	.967	.977	.987	.982	.994	1.887	1.887	e.
6	0.8	1.1	-------	.636	.747	.832	.880	.917	.967	.979	.987	.984	.988	1.907	1.907	e.
9	1.6	2.7	1.509	.650	.755	.830	.873	.908	.960	.974	.986	.976	.992	1.937	1.938	e.
16	2.2	2.4	1.500	.642	.744	.829	.873	.907	.962	.969	.980	.978	.992	1.929	1.930	e.
17	1.6	2.4	-------	.639	.734	.827	.877	.914	.962	.968	.980	.972	.990	1.923	1.924	e.
21	2.9	2.9	1.446	.637	.735	.824	.871	.905	.957	.968	.980	.976	.992	1.887	1.888	e.
26	2.7	3.0	-------	.638	.739	.831	.873	.906	.963	.973	.983	.980	.992	1.905	1.906	e.−
27	2.1	0.9	1.522	.648	.746	.828	.877	.913	.968	.977	.986	.984	.988	1.903	1.903	e.
28	1.8	1.1	1.510	.661	.740	.825	.878	.910	.962	.974	.984	.984	.987	1.905	1.905	e.
Mar. 2	2.6	6.5	1.431	.641	.743	.833	.877	.915	.965	.977	.987	.982	.990	1.909	1.908	e.
5	3.7	6.3	1.430	.633	.744	.832	.875	.912	.966	.976	.980	.980	.989	1.906	1.906	e.
11	2.8	1.7	1.492	.635	.737	.828	.874	.907	.960	.970	.981	.982	.982	1.937	1.937	e.
12	2.4	2.4	1.465	.642	.737	.828	.872	.904	.957	.968	.978	.977	.984	1.929	1.930	e.
16	3.6	8.6	-------	.616	.708	.815	.848	.882	.944	.958	.975	.970	.979	1.967	1.963	e.
23	2.6	3.7	1.459	.646	.741	.822	.872	.911	.962	.974	.982	.982	.983	1.928	1.929	e.
24	3.3	7.2	1.433	.642	.744	.832	.881	.913	.964	.977	.982	.978	.989	1.924	1.922	e.
25	4.4	7.3	1.405	.625	.719	.803	.855	.883	.954	.968	.978	.979	.987	1.952	1.950	g.+
27	2.8	4.0	1.428	.605	.711	.796	.849	.887	.942	.958	.969	.967	.978	1.961	1.962	e.−
28	3.0	6.2	1.346	.590	.694	.788	.833	.875	.925	.939	.952	.953	.957	1.939	1.939	v.g.
30	2.8	6.3	1.394	.635	.726	.808	.857	.893	.950	.962	.973	.972	.986	1.911	1.911	e.
31	3.9	5.4	1.385	.620	.714	.798	.847	.888	.942	.958	.968	969	980	1 927	1 928	e.−
Apr. 14	5.0	6.8	1.383	.641	.727	.808	.858	.892	.950	.962	.975	.972	.984	1.897	1.896	e.−
15	4.9	8.0	1.374	.655	.690	.778	.837	.887	.942	.960	.977	.982	.987	1.934	1.931	v.g.
16	4.7	8.6	1.317	.610	.665	.747	.802	.873	.933	.953	.967	.967	.984	1.953	1.949	v.g.
20	4.3	5.0	-------	.630	.720	.802	.847	.881	.935	.948	.960	.962	.979	1.893	1.894	v.g.
21	4.0	7.2	1.359	.650	.723	.808	.855	.885	.945	.957	.966	.967	.982	1.893	1.891	e.−
22	3.6	5.9	1.390	.636	.710	.795	.842	.883	.937	.951	.962	.963	.975	1.936	1.936	v.g.+
23	4.7	5.6	1.419	.650	.736	.824	.874	.912	.964	.974	.982	.982	.990	1.888	1.888	vg.
24	5.6	8.6	1.353	.655	.716	.792	.841	.883	.938	.953	.965	.963	.987	1.920	1.916	e.−
25	5.7	12.0	1.293	.656	.705	.792	.841	.878	.938	.948	.960	.961	.978	1.900	1.899	v.g.+
30	7.6	14.3	-------	.579	.632	.724	.772	.840	.898	.926	.942	.948	.967	1.891	1.893	v.g.+
May 6	3.0	2.3	-------	.455	.501	.591	.648	.711	.798	.832	.872	.898	.937	1.907	1.908	g.−
8	2.5	1.7	1.204	.497	.583	.665	.736	.804	.877	.900	.926	.938	.962	1.896	1.896	v.g.
10	3.2	3.9	1.283	.554	.646	.735	.795	.843	.907	.923	.940	.948	.973	1.912	1.913	e.−
12	4.0	5.0	1.372	.614	.695	.789	.838	.878	.937	.952	.963	.966	.980	1.929	1.930	e.

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TABLE 29*b*.—*Solar-constant values. Long method. Table Mountain, 1925–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46 0.348 μ	38 0.391 μ	32 0.446 μ	28 0.497 μ	22 0.615 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1926	*Mm*	*Mm*														
May 13	4.2	6.1	-------	0.607	0.694	0.780	0.831	0.877	0.932	0.944	0.962	0.962	0.972	1.963	1.963	v.g.—
14	5.2	4.1	1.387	.621	.715	.802	.852	.893	.948	.962	.972	.974	.979	1.887	1.888	v.g.+
15	4.5	2.4	1.438	.629	.728	.807	.858	.896	.947	.960	.972	.971	.982	1.934	1.935	e.—
16	4.4	4.1	1.404	.640	.724	.808	.863	.892	.944	.957	.969	.968	.979	1.925	1.926	e.—
17	4.3	3.4	1.423	.640	.726	.808	.854	.890	.947	.957	.969	.967	.978	1.935	1.936	e.—
19	3.9	3.2	1.461	.653	.742	.824	.873	.902	.958	.970	.980	.978	.986	1.937	1.938	e.
20	5.4	4.2	1.448	.650	.735	.818	.865	.900	.952	.967	.977	.976	.986	1.958	1.959	v.g.+
21	6.8	6.3	1.344	.630	.716	.797	.840	.878	.935	.948	.962	.963	.978	1.935	1.935	v.g.
22	7.2	5.4	1.317	.620	.688	.768	.823	.862	.907	.922	.940	.938	.956	1.967	1.968	v.g.
26	4.5	6.2	1.319	.596	.689	.767	.822	.863	.924	.942	.960	.964	.978	1.903	1.903	e.—
29	5.4	10.2	1.192	.555	.630	.719	.774	.823	.885	.908	.930	.938	.957	1.929	1.926	v.g.+
30	6.2	7.7	1.316	.585	.697	.781	.835	.873	.928	.945	.957	.960	.979	1.919	1.916	e.—
June 1	6.2	6.8	1.328	.607	.692	.771	.830	.861	.918	.934	.948	.949	.972	1.954	1.953	v.g.+
2	5.8	6.5	1.365	.610	.698	.789	.841	.878	.933	.948	.961	.960	.977	1.969	1.968	e.
4	6.6	6.7	1.343	.586	.687	.775	.832	.875	.933	.949	.964	.962	.978	1.927	1.928	e.
9	6.7	11.0	1.310	.582	.672	.764	.824	.870	.923	.940	.958	.958	.975	1.978	1.975	e.—
10	5.3	7.9	1.382	.620	.705	.793	.849	.889	.943	.958	.971	.970	.983	1.942	1.939	e.
11	4.9	10.9	1.306	.587	.682	.775	.825	.867	.928	.947	.960	.962	.984	1.938	1.935	v.g.+
14	3.8	2.4	1.439	.630	.728	.812	.863	.901	.950	.963	.976	.968	.982	1.923	1.924	e.—
15	3.2	4.8	1.419	.640	.737	.824	.870	.910	.962	.971	.978	.973	.983	1.923	1.924	v.g.+
16	4.9	4.1	1.379	.625	.709	.790	.828	.878	.929	.943	.954	.953	.972	1.950	1.951	e.
19	4.4	2.5	1.450	.645	.731	.822	.870	.903	.952	.965	.975	.972	.984	1.928	1.929	e.
21	4.5	5.4	1.446	.657	.747	.827	.875	.910	.959	.972	.982	.980	.987	1.938	1.939	e.—
30	6.1	8.1	1.372	.609	.705	.795	.849	.894	.944	.956	.968	.966	.975	1.958	1.954	e.
July 1	4.9	4.2	1.436	.624	.722	.816	.865	.905	.953	.967	.977	.974	.987	1.935	1.936	e.
3	5.6	10.3	1.366	.632	.704	.812	.862	.899	.952	.966	.978	.974	.985	1.930	1.927	e.
7	3.2	3.6	1.468	.644	.743	.828	.881	.913	.960	.970	.980	.977	.989	1.949	1.950	e.
8	2.6	1.2	1.511	.632	.745	.828	.877	.908	.959	.972	.982	.977	.990	1.940	1.940	e.
15	6.3	15.2	1.178	.531	.566	.667	.741	.823	.895	.923	.945	.954	.976	1.983	1.987	v.g.
21	4.0	5.4	1.433	.641	.728	.825	.878	.912	.964	.976	.981	.977	.993	1.931	1.932	e.
23	2.8	1.6	1.509	.657	.742	.833	.878	.912	.962	.972	.983	.982	.992	1.947	1.947	e.
28	1.8	1.8	1.502	.660	.745	.830	.881	.918	.966	.972	.985	.984	.994	1.932	1.932	e.
31	7.3	13.8	1.324	.627	.711	.807	.854	.896	.949	.964	.975	.972	.986	1.888	1.890	e.
Aug. 3	6.1	16.8	-------	.590	.685	.793	.842	.884	.937	.958	.970	.973	.983	1.927	1.935	v.g.+
10	5.3	3.8	1.448	.659	.733	.823	.870	.912	.958	.969	.977	.974	.989	1.936	1.937	e.
26	7.1	15.6	1.328	.612	.716	.809	.859	.906	.953	.965	.976	.972	.987	1.890	1.896	v.g.+
Sept. 3	2.5	4.4	1.468	.645	.743	.830	.880	.915	.962	.975	.981	.976	.992	1.946	1.947	e.
4	2.1	3.3	1.475	.645	.738	.825	.874	.915	.963	.976	.985	.986	.994	1.930	1.931	e.
10	7.2	8.0	1.439	.646	.741	.831	.880	.915	.961	.976	.984	.981	.992	1.944	1.940	e.—
13	1.6	2.4	1.498	.650	.745	.833	.883	.923	.967	.978	.986	.984	.994	1.922	1.923	e.
17	3.9	6.6	1.431	.655	.740	.826	.872	.914	.956	.969	.980	.978	.987	1.940	1.939	e.
24	2.8	3.0	1.483	.665	.750	.836	.886	.921	.966	.976	.984	.979	.990	1.918	1.919	e.
28	5.5	5.5	1.436	.652	.727	.818	.865	.900	.950	.965	.976	.973	.985	1.955	1.955	e.
Oct. 4	4.0	7.0	1.440	.640	.739	.825	.876	.914	.959	.971	.982	.972	.984	1.940	1.938	e.
12	4.2	5.0	1.461	.652	.737	.826	.875	.910	.961	.973	.982	.981	.995	1.942	1.943	e.
16	5.1	5.1	1.445	.621	.734	.831	.875	.915	.966	.973	.984	.986	.986	1.929	1.930	e.—
26	3.5	6.5	1.445	.656	.741	.827	.873	.912	.960	.972	.984	.983	.984	1.939	1.938	e.—
30	2.0	1.8	1.484	.646	.731	.815	.866	.907	.952	.967	.978	.970	.980	1.960	1.960	e.—
Nov. 6	2.4	4.0	1.476	.655	.740	.828	.878	.913	.964	.977	.985	.985	.987	1.933	1.934	e.
Dec. 6	4.0	8.8	1.354	.680	.752	.840	.885	.918	.962	.971	.976	.972	.981	1.900	1.896	e.
11	3.1	8.0	1.437	.661	.733	.827	.872	.905	.952	.964	.972	.966	.975	1.950	1.946	e.—
1927																
Jan. 12	2.2	3.3	1.472	.657	.739	.823	.877	.911	.961	.971	.985	.980	.986	1.916	1.917	e.
23	1.4	0.7	1.528	.661	.731	.824	.873	.907	.956	.970	.981	.975	.987	1.936	1.936	e.—
Feb. 1	2.3	2.7	1.467	.665	.738	.822	.867	.905	.955	.965	.976	.975	.983	1.930	1.931	e.
25	5.6	7.1	1.444	.679	.744	.827	.875	.913	.960	.971	.976	.972	.981	1.937	1.934	e.
27	1.4	0.9	1.482	.666	.735	.825	.875	.906	.960	.975	.986	.980	.989	1.877	1.877	e.—
28	1.6	1.2	1.486	.632	.720	.800	.852	.892	.942	.958	.970	.972	.979	1.965	1.965	e.
Mar. 7	3.0	4.0	1.434	.637	.731	.821	.861	.904	.956	.970	.977	.974	.984	1.919	1.920	e.—
13	2.0	6.6	1.410	.640	.722	.811	.865	.901	.954	.967	.978	.979	.980	1.929	1.928	e.
19	1.8	1.1	1.486	.646	.726	.816	.861	.894	.941	.961	.972	.970	.980	1.945	1.945	e.
24	4.5	1.3	1.471	.645	.725	.815	.861	.895	.950	.958	.967	.970	.974	1.933	1.933	c.

TABLE 29b.—*Solar-constant values. Long method. Table Mountain, 1925–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths: Place and wave length 46 (0.348 μ)	38 (0.391 μ)	32 (0.446 μ)	28 (0.497 μ)	22 (0.615 μ)	19 (0.724 μ)	17 (0.817 μ)	14 (0.994 μ)	11 (1.225 μ)	6 (1.600 μ)	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1927	*Mm*	*Mm*														
Apr. 4	3.8	1.5	1.467	0.650	0.725	0.810	0.858	0.896	0.941	0.954	0.961	0.960	0.970	1.957	1.957	e.
14	3.0	4.7	1.428	.628	.714	.810	.858	.900	.951	.966	.976	.974	.982	1,935	1.936	e.
18	2.7	3.9	1.443	.662	.736	.825	.874	.902	.955	.966	.977	.977	.983	1.920	1.921	e.
23	3.2	4.0	1.460	.656	.741	.836	.882	.911	.964	.977	.986	.981	.984	1.923	1.924	e.
28	3.1	3.0	1.481	.641	.740	.831	.874	.912	.960	.970	.980	.975	.982	1.938	1.939	e.
May 3	4.3	4.5	1.425	.646	.733	.820	.871	.905	.956	.970	.980	.976	.986	1.915	1.916	e.
10	3.9	5.3	1.380	.631	.716	.807	.853	.893	.945	.956	.961	.963	.974	1.919	1.920	e.–
13	4.7	6.7	1.431	.651	.740	.826	.877	.913	.964	.973	.985	.984	.988	1.928	1.927	e.
25	3.9	4.4	1.440	.641	.730	.819	.866	.908	.955	.965	.976	.974	.981	1.943	1.944	e.
31	3.6	2.3	1.478	.654	.735	.821	.869	.900	.954	.968	.976	.975	.985	1.946	1.947	e.
June 6	6.4	6.8	1.337	.627	.705	.792	.838	.881	.927	.942	.952	.950	.968	1.944	1.943	e.
14	7.7	10.5	1.327	.636	.711	.800	.844	.887	.841	.958	.965	.968	.972	1.906	1.903	e.–
20	4.7	4.6	1.402	.635	.720	.807	.857	.896	.945	.959	.966	.970	.976	1.935	1.936	e.
28	4.2	2.9	1.438	.644	.720	.815	.857	.896	.950	.960	.974	.966	.977	1.944	1.945	v.g.+
July 9	8.6	21.1	1.295	.600	.695	.792	.845	.882	.944	.966	.979	.976	.980	1.944	1.964	e.–
15	5.3	3.0	1.474	.655	.740	.835	.880	.920	.966	.980	.982	.983	.988	1.916	1.917	e.
28	7.7	15.8	1.307	.590	.689	.782	.834	.884	.939	.960	.970	.972	.980	1.937	1.943	e.
Aug. 2	2.9	1.7	1.526	.641	.731	.826	.875	.914	.960	.974	.979	.977	.987	1.973	1.973	e.–
4	3.8	11.1	1.406	.632	.737	.825	.875	.911	.960	.976	.984	.980	.986	1.931	1.929	e.–
7	7.1	14.2	1.345	.635	.711	.810	.857	.904	.950	.966	.975	.976	.982	1.916	1.918	e.–
8	6.6	9.8	1.382	.660	.731	.825	.874	.911	.960	.975	.980	.982	.980	1.914	1.910	v.g.+
9	6.2	10.6	1.356	.621	.701	.795	.851	.896	.948	.963	.970	.970	.976	1.948	1.945	e.
14	5.5	7.8	1.444	.652	.741	.830	.878	.915	.960	.974	.985	.980	.982	1.950	1.947	e.
15	5.6	13.0	1.404	.651	.740	.841	.888	.922	.967	.981	.985	.980	.984	1.923	1.925	e.–
16	8.7	22.0	1.301	.639	.729	.822	.865	.911	.958	.975	.976	.974	.969	1.886	1.906	v.g.+
20	10.3	20.0	1.307	.680	.731	.822	.865	.915	.958	.972	.984	.980	.983	1.871	1.891	v.g.+
21	7.1	12.4	1.404	.645	.675	.835	.881	.920	.964	.977	.985	.981	.986	1.936	1.935	e.–
23	5.3	8.5	1.429	.632	.736	.829	.875	.922	.965	.975	.985	.982	.987	1.933	1.929	e.
29	4.2	6.5	1.432	.643	.735	.825	.876	.914	.962	.974	.984	.980	.986	1.941	1.941	e.
31	3.2	2.9	1.483	.646	.748	.825	.882	.915	.962	.974	.982	.980	.986	1.943	1.944	e.
Sept. 4	4.2	3.2	1.453	.645	.735	.812	.866	.901	.952	.961	.974	.973	.984	1.962	1.963	v.g.+
9	1.9	5.8	1.447	.635	.741	.831	.880	.915	.962	.975	.982	.978	.985	1.939	1.939	e.
13	3.2	1.6	1.478	.637	.738	.826	.876	.915	.961	.975	.985	.984	.985	1.917	1.917	v.g.
17	5.4	5.9	1.453	.655	.739	.832	.875	.920	.965	.976	.984	.981	.983	1.938	1.938	e.
22	5.0	12.5	1.372	.635	.715	.805	.859	.904	.955	.968	.979	.976	.982	1.944	1.944	e.–
29	3.6	6.9	1.450	.632	.744	.830	.885	.920	.967	.989	.994	.985	.994	1.921	1.920	e.
Oct. 6	2.8	2.1	1.499	.662	.744	.833	.875	.915	.959	.976	.985	.981	.990	1.936	1.937	e.
13	3.2	5.9	1.422	.651	.730	.816	.869	.910	.961	.973	.982	.970	.988	1.931	1.931	v.g.+
17	5.0	7.6	1.412	.632	.721	.810	.864	.907	.956	.967	.982	.984	.990	1.934	1.931	e.
18	5.0	9.4	1.377	.626	.719	.810	.863	.905	.957	.969	.979	.975	.985	1.904	1.900	v.g.+
19	4.4	4.6	1.442	.640	.724	.820	.865	.905	.950	.965	.975	.873	.990	1.967	1.968	v.g.+
Nov. 2	2.3	5.0	1.464	.634	.738	.825	.878	.921	.964	.979	.988	.986	.985	1.934	1.935	e.
7	4.7	6.7	1.449	.676	.748	.834	.875	.926	.969	.978	.986	.984	.989	1.922	1.921	e.
11	2.8	3.1	1.486	.650	.744	.830	.881	.923	.965	.974	.985	.981	.985	1.944	1.945	e.
18	3.0	4.7	1.463	.670	.754	.837	.886	.928	.968	.984	.987	.985	.994	1.910	1.911	e.
23	3.0	0.6	1.554	.665	.745	.827	.876	.919	.964	.974	.981	.976	.989	1.948	1.948	e.
30	3.4	5.3	-------	.674	.737	.822	.870	.909	.951	.963	.971	.973	.984	1.962	1.963	v.g.+
Dec. 6	2.7	1.3	1.517	.656	.747	.825	.884	.923	.964	.976	.984	.981	.991	1.927	1.927	e.
12	2.6	2.1	1.497	.685	.751	.835	.875	.915	.965	.976	.985	.982	.987	1.924	1.925	e.
19	2.6	3.1	1.491	.663	.746	.830	.875	.920	.961	.972	.982	.980	.987	1.943	1.944	e.
1928																
Jan. 3	4.1	9.0	-------	.669	.741	.831	.880	.918	.963	.975	.985	.974	.988	1.923	1.919	e.–
5	3.6	2.9	-------	.650	.737	.827	.873	.921	.962	.975	.986	.980	.989	1.931	1.932	e.
9	2.7	2.9	1.479	.646	.735	.831	.878	.914	.965	.976	.986	.981	.987	1.918	1.919	e.–
18	1.5	0.9	1.518	.645	.736	.825	.876	.914	.963	.973	.982	.976	.988	1.926	1.926	e.
20	2.4	1.4	1.504	.641	.731	.817	.872	.911	.957	.971	.981	.980	.987	1.941	1.941	e.
29	5.2	7.7	-------	.655	.737	.830	.876	.914	.961	.972	.981	.981	.982	1.943	1.940	v.g.+
Feb. 6	2.8	3.3	1.431	.645	.718	.806	.858	.894	.941	.951	.962	.960	.966	1.967	1.968	e.–
8	3.1	3.0	1.454	.656	.733	.818	.866	.908	.952	.964	.978	.975	.980	1.922	1.923	e.
17	2.3	1.9	1.502	.660	.745	.832	.878	.912	.961	.975	.981	.979	.989	1.925	1.925	e.
27	3.4	1,9	1.509	.664	.739	.823	.878	.920	.966	.976	.982	.981	.990	1.936	1.936	e.
Mar. 7	3.1	2.2	1.483	.651	.731	.818	.862	.904	.956	.967	.980	.976	.983	1.946	1.947	e.
15	2.8	2.8	1.392	.624	.714	.796	.847	.880	.934	.949	.957	.956	.972	1.931	1.932	e.

Table 29*b*.—*Solar-constant values. Long method. Table Mountain, 1925–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				46 0.348 μ	38 0.391 μ	32 0.446 μ	28 0.497 μ	22 0.615 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ			
1928	*Mm*	*Mm*														
Mar. 19	3.6	1.5	1.434	0.631	0.704	0.790	0.845	0.886	0.941	0.956	0.966	0.966	0.977	1.942	1.942	e.
26	4.2	2.4	1.488	.647	.738	.832	.877	.919	.963	.975	.984	.982	.988	1.935	1.936	e.
29	2.8	2.3	1.409	.630	.721	.802	.846	.881	.935	.947	.957	.956	.970	1.942	1.943	e.
Apr. 5	3.1	4.5	1.383	.630	.716	.812	.854	.889	.940	.952	.960	.960	.967	1.905	1.906	e.—
16	3.6	2.2	-------	.658	.733	.815	.868	.904	.958	.972	.981	.976	.984	1.940	1.941	e.—
28	3.3	8.0	1.339	.645	.711	.795	.843	.880	.933	.946	.957	.959	.970	1.924	1.920	e.—
May 3	2.5	3.6	1.327	.617	.688	.771	.820	.855	.912	.924	.935	.937	.953	1.962	1.963	v.g.
11	6.5	13.4	1.283	.611	.689	.777	.829	.868	.924	.940	.945	.949	.953	1.966	1.967	v.g.
16	4.5	10.4	1.286	.625	.685	.778	.821	.867	.926	.945	.955	.956	.970	1.941	1.936	e.
23	5.2	9.4	1.303	.620	.696	.779	.833	.875	.929	.944	.953	.954	.963	1.949	1.945	e.—
29	4.1	6.3	1.360	.613	.706	.784	.841	.889	.938	.954	.965	.965	.970	1.959	1.959	g.
June 12	5.1	7.2	1.383	.638	.720	.795	.853	.891	.949	.963	.972	.971	.969	1.973	1.971	v.g.
18	4.8	7.3	1.369	.631	.720	.808	.859	.894	.943	.954	.962	.957	.963	1.958	1.956	v.g.
22	2.3	2.4	1.490	.630	.745	.833	.882	.916	.970	.975	.985	.985	.985	1.944	1.945	v.g.
27	3.4	3.6	1.478	.630	.754	.838	.887	.919	.969	.981	.991	.986	.990	1.924	1.925	e.
July 3	2.7	8.1	1.428	.653	.750	.835	.888	.927	.969	.983	.989	.982	.995	1.916	1.912	v.g.
10	4.3	4.2	1.436	.637	.748	.834	.882	.917	.965	.977	.985	.980	.991	1.907	1.908	e.—
19	2.5	2.7	1.479	.655	.740	.829	.878	.915	.966	.976	.981	.981	.986	1.931	1.932	e.
23	3.9	6.0	1.438	.643	.738	.822	.878	.915	.965	.976	.985	.982	.985	1.933	1.933	e.—
Aug. 1	3.0	6.8	1.418	.615	.725	.815	.863	.912	.958	.972	.981	.980	.984	1.936	1.935	e.—
7	4.5	5.0	1.430	.647	.725	.823	.869	.912	.963	.974	.981	.981	.986	1.913	1.914	e.—
13	5.2	20.0	1.222	.582	.655	.742	.813	.864	.921	.942	.958	.963	.967	1.914	1.929	v.g.
22	2.2	5.8	1.419	.631	.717	.809	.864	.906	.959	.970	.981	.982	.984	1.936	1.936	v.g.+
25	3.3	3.2	1.429	.644	.722	.812	.862	.912	.963	.974	.980	.980	.985	1.931	1.932	g.+
31	1.1	0.6	1.532	.635	.737	.831	.876	.918	.968	.976	.981	.980	.986	1.940	1.940	e.—
Sept. 6	4.8	8.8	1.360	.610	.686	.788	.843	.897	.950	.964	.978	.977	.982	1.934	1.930	v.g.+
11	1.6	3.3	1.465	.660	.751	.837	.887	.926	.971	.979	.986	.985	.987	1.904	1.905	e.—
15	3.4	13.8	-------	.635	.725	.815	.869	.912	.958	.970	.978	.976	.978	1.923	1.925	v.g.
18	1.8	3.7	1.477	.646	.741	.835	.886	.925	.971	.980	.986	.985	.987	1.927	1.928	e.
21	2.3	3.4	1.452	.625	.739	.828	.875	.916	.961	.973	.982	.981	.986	1.930	1.931	e.
30	3.3	1.6	1.497	.630	.730	.818	.871	.916	.965	.975	.983	.982	.987	1.932	1.932	e.
Oct. 3	2.4	5.3	1.441	.656	.750	.837	.880	.923	.971	.980	.986	.985	.985	1.892	1.893	v.g.+
8	3.1	3.9	1.446	.641	.732	.822	.869	.912	.964	.976	.985	.981	.985	1.925	1.926	v.g.+
15	2.9	7.1	1.437	.646	.740	.825	.875	.919	.966	.977	.985	.985	.987	1.913	1.911	e.
22	3.5	5.4	1.448	.642	.735	.832	.876	.918	.966	.978	.986	.985	.988	1.913	1.914	e.—
Nov. 4	4.7	6.2	1.454	.647	.751	.832	.878	.925	.973	.978	.983	.983	.987	1.904	1.904	v.g.+
8	2.3	1.5	1.497	.645	.732	.827	.874	.915	.963	.975	.982	.980	.988	1.927	1.927	e.—
16	2.1	7.2	1.435	.661	.739	.832	.882	.924	.965	.978	.986	.986	.987	1.915	1.913	e.—
20	2.0	2.4	1.487	.651	.741	.830	.876	.912	.964	.975	.983	.981	.988	1.930	1.931	e.—
28	2.2	2.0	1.507	.654	.741	.828	.877	.919	.966	.976	.985	.982	.983	1.925	1.925	e.
Dec. 7	2.3	4.8	1.425	.631	.725	.821	.870	.905	.966	.971	.976	.980	.974	1.900	1.901	v.g.+
8	3.3	4.7	1.445	.656	.727	.822	.873	.917	.966	.975	.982	.979	.985	1.920	1.921	e.
9	2.9	3.6	1.469	.654	.750	.832	.882	.918	.970	.981	.986	.984	.987	1.912	1.913	e.
10	3.0	6.2	1.429	.660	.733	.830	.876	.912	.961	.972	.985	.981	.983	1.915	1.915	v.g.+
14	2.3	3.0	-------	.651	.722	.810	.873	.905	.962	.976	.985	.984	.988	1.922	1.923	v.g.
16	1.9	2.1	1.478	.648	.720	.817	.864	.898	.958	.974	.982	.982	.986	1.930	1.931	v.g.+
17	1.7	2.7	1.473	.672	.734	.823	.873	.918	.964	.975	.984	.984	.983	1.911	1.912	e.—
18	1.6	1.8	1.484	.640	.731	.816	.866	.904	.955	.970	.984	.982	.985	1.947	1.948	e.
19	2.4	1.2	1.511	.669	.745	.827	.873	.908	.962	.975	.985	.981	.988	1.941	1.941	e.
20	2.5	2.0	1.496	.676	.748	.822	.876	.912	.965	.975	.984	.982	.984	1.926	1.927	e.
21	2.7	0.9	1.517	.665	.736	.825	.880	.918	.964	.979	.986	.985	.990	1.896	1.896	v.g.+
22	2.4	0.8	1.522	.677	.740	.830	.878	.913	.964	.974	.984	.981	.987	1.921	1.921	e.—
23	2.2	1.2	1.517	.637	.739	.830	.878	.915	.969	.976	.985	.983	.987	1.923	1.923	e.
26	4.5	2.6	1.489	.651	.740	.830	.882	.918	.966	.979	.984	.984	.987	1.935	1.936	e.
28	3.1	2.0	1.492	.651	.735	.831	.875	.916	.965	.975	.982	.982	.988	1.940	1.940	e.
29	2.7	7.0	1.439	.639	.736	.822	.882	.923	.971	.983	.988	.990	.990	1.910	1.908	v.g.
30	2.7	2.3	1.485	.646	.732	.822	.872	.912	.965	.977	.983	.983	.988	1.931	1.932	e.—
31	2.1	2.4	1.488	.672	.746	.835	.879	.918	.966	.978	.986	.985	.989	1.918	1.919	e.—
1929																
Jan. 8	2.2	2.4	1.481	.645	.725	.822	.867	.910	.960	.977	.985	.981	.988	1.940	1.941	e.—
9	1.7	1.7	1.505	.645	.736	.822	.879	.918	.970	.980	.984	.986	.986	1.927	1.927	v.g.
10	2.0	2.4	1.494	.631	.731	.832	.884	.919	.968	.976	.985	.982	.987	1.906	1.907	v.g.+
11	2.5	2.0	1.503	.661	.745	.826	.882	.918	.970	.982	.988	.988	.988	1.912	1.912	v.g.+

TABLE 29*b*.—*Solar-constant values. Long method. Table Mountain, 1925–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.348 μ	38 0.391 μ	32 0.446 μ	28 0.497 μ	22 0.615 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ			
1929	*Mm*	*Mm*														
Jan. 12	2.5	2.1	1.499	0.655	0.732	0.828	0.883	0.921	0.971	0.981	0.983	0.983	0.987	1.908	1.909	e.
14	1.8	3.8	1.496	.670	.741	.828	.883	.918	.963	.975	.983	.982	.986	1.933	1.934	v.g.+
17	2.7	3.3	1.455	.645	.732	.819	.870	.897	.959	.973	.982	.979	.982	1.925	1.926	e.−
18	3.4	5.3	-------	.641	.747	.831	.880	.927	.967	.981	.987	.985	.987	1.896	1.896	v.g.+
22	2.3	2.4	1.460	.656	.740	.827	.874	.907	.958	.970	.977	.976	.979	1.915	1.916	e.−
25	2.1	2.3	1.473	.655	.732	.824	.876	.912	.961	.973	.983	.982	.986	1.921	1.922	e.
26	1.9	2.0	1.499	.646	.749	.836	.884	.916	.963	.976	.988	.985	.990	1.884	1.885	v. g.−
29	3.7	6.7	1.436	.670	.742	.824	.882	.921	.967	.979	.987	.987	.991	1.892	1.891	e.−
Feb. 9	1.0	0.4	1.542	.653	.739	.827	.874	.912	.962	.973	.984	.983	.984	1.930	1.930	e.
11	2.1	3.9	1.442	.644	.737	.816	.869	.912	.960	.972	.981	.980	.983	1.913	1.914	e.
12	2.1	1.7	1.485	.654	.734	.826	.873	.908	.963	.975	.984	.983	.986	1.916	1.916	e.
13	1.9	4.8	1.441	.646	.735	.832	.875	.912	.963	.975	.985	.984	.986	1.901	1.902	v.g.
14	2.3	3.2	-------	.659	.744	.827	.877	.908	.962	.976	.988	.987	.986	1.905	1.906	v.g.
15	1.5	1.3	1.506	.647	.734	.826	.870	.906	.958	.972	.982	.981	.987	1.931	1.931	v.g.+
20	2.1	2.8	1.475	.642	.735	.826	.870	.908	.963	.974	.984	.985	.987	1.929	1.930	e.
21	1.3	1.3	1.524	.646	.737	.824	.873	.912	.962	.975	.985	.984	.989	1.934	1.934	e.−
Mar. 5	2.6	3.2	1.472	.642	.736	.830	.882	.915	.964	.975	.981	.980	.985	1.920	1.921	e.−
8	2.8	4.8	-------	.633	.730	.825	.874	.907	.964	.976	.987	.984	.985	1.915	1.916	v.g.+
14	2.6	4.4	1.389	.600	.696	.791	.839	.879	.937	.951	.963	.965	.971	1.943	1.944	v.g.+
16	2.8	4.5	1.379	.614	.700	.791	.842	.886	.944	.960	.970	.969	.977	1.916	1.917	e.−
20	2.5	1.7	1.466	.629	.721	.814	.852	.900	.954	.967	.976	.975	.981	1.926	1.926	e.
23	2.2	2.4	1.422	.610	.687	.786	.824	.874	.931	.943	.960	.962	.972	1.974	1.975	v.g.
24	1.6	1.3	1.491	.635	.732	.816	.864	.904	.958	.972	.980	.979	.984	1.925	1.925	e.
25	2.4	2.0	1.443	.633	.732	.826	.864	.902	.959	.971	.979	.980	.984	1.879	1.879	v.g.−
26	2.0	2.3	1.453	.634	.725	.812	.863	.896	.956	.970	.982	.981	.984	1.917	1.918	e.−
27	3.0	5.1	1.451	.640	.734	.824	.871	.907	.959	.971	.980	.980	.985	1.924	1.925	e.−
Apr. 6	1.7	0.9	1.469	.620	.709	.785	.843	.886	.947	.964	.973	.974	.983	1.936	1.936	e.−
7	1.6	1.4	1.368	.619	.701	.802	.852	.879	.937	.952	.965	.966	.974	1.838	1.838	e.−
8	2.4	3.5	1.406	.620	.697	.784	.829	.867	.924	.941	.961	.965	.967	1.957	1.958	v.g.
9	1.8	1.4	1.471	.634	.730	.810	.853	.891	.950	.961	.973	.972	.980	1.939	1.939	e.
13	2.7	2.1	1.418	.622	.712	.796	.845	.876	.936	.952	.963	.963	.966	1.940	1.941	e.−
20	1.9	2.5	1.292	.594	.665	.745	.782	.829	.889	.904	.923	.925	.946	1.946	1.947	e.−
21	4.2	3.9	1.202	.616	.703	.776	.830	.854	.910	.926	.940	.940	.944	1.903	1.904	v.g.
22	2.9	5.6	1.405	.654	.746	.814	.864	.896	.949	.962	.969	.972	.976	1.921	1.921	e.
23	2.6	4.4	1.394	.606	.696	.781	.836	.878	.940	.955	.974	.974	.976	1.954	1.955	e.−
May 3	3.1	5.2	1.414	.631	.738	.826	.867	.905	.952	.962	.979	.977	.981	1.896	1.897	e.−
4	2.9	4.3	1.454	.643	.733	.824	.874	.906	.960	.971	.978	.976	.985	1.936	1.937	e.
8	2.6	2.3	1.428	.610	.712	.807	.853	.889	.937	.945	.957	.965	.971	1.946	1.947	e.−
10	3.1	5.6	1.373	.615	.716	.804	.849	.886	.938	.949	.958	.959	.964	1.946	1.946	e
11	2.7	1.4	1.433	.620	.699	.796	.845	.884	.943	.955	.965	.966	.974	1.946	1.946	e.
17	4.1	7.9	1.352	.601	.697	.800	.836	.884	.938	.954	.966	.970	.972	1.943	1.940	e.
22	5.0	9.8	1.269	.582	.666	.749	.806	.850	.915	.933	.949	.955	.957	1.956	1.952	v.g.+
23	5.7	11.8	1.233	.552	.625	.722	.775	.830	.904	.923	.950	.957	.963	1.948	1.945	v.g.+
24	4.4	6.5	-------	.587	.670	.757	.812	.858	.915	.931	.944	.948	.953	1.875	1.875	v.g.−
28	2.6	3.5	1.372	.615	.711	.797	.846	.888	.945	.959	.969	.972	.975	1.875	1.876	e.−
June 3	2.4	3.5	1.435	.637	.725	.815	.864	.905	.956	.966	.977	.975	.976	1.909	1.910	e.−
17	1.7	2.7	1.411	.622	.712	.802	.849	.894	.944	.958	.973	.975	.980	1.905	1.906	e.
18	3.9	4.9	1.435	.636	.732	.824	.873	.910	.961	.971	.978	.982	.979	1.921	1.922	v.g.+
19	3.2	3.4	1.447	.636	.730	.816	.864	.906	.956	.968	.982	.983	.984	1.929	1.930	e.
20	4.4	3.1	1.446	.642	.732	.816	.858	.905	.955	.966	.979	.979	.979	1.924	1.925	e.
23	2.7	1.8	1.494	.645	.738	.827	.874	.914	.916	.973	.982	.983	.982	1.935	1.935	e.−
24	2.9	2.4	1.471	.645	.729	.822	.872	.909	.966	.976	.984	.984	.987	1.912	1.913	v.g.+
25	3.9	3.9	1.440	.645	.729	.821	.867	.911	.960	.971	.982	.982	.983	1.915	1.916	e.
26	4.3	5.4	1.371	.630	.711	.801	.848	.897	.947	.960	.972	.976	.977	1.917	1.918	e.
July 3	5.4	6.9	1.290	.588	.671	.756	.812	.871	.926	.943	.956	.957	.970	1.912	1.910	v.g.+
6	6.1	9.4	1.270	.582	.682	.766	.828	.876	.930	.950	.966	.963	.967	1.879	1.875	v.g.
9	5.9	9.5	1.292	.596	.662	.755	.812	.864	.916	.941	.956	.958	.962	1.961	1.957	v.g.
11	3.1	3.7	1.431	.622	.725	.805	.865	.905	.950	.966	.973	.971	.977	1.931	1.932	e.−
13	4.9	9.7	1.360	.625	.723	.811	.861	.896	.946	.961	.973	.973	.976	1.911	1.907	e.−
19	4.8	13.9	1.340	.635	.711	.810	.861	.901	.953	.965	.978	.976	.980	1.909	1.911	e.−
27	3.9	8.8	1.381	.630	.716	.801	.853	.895	.948	.960	.972	.974	.978	1.940	1.936	e.−
30	5.3	10.6	1.334	.595	.676	.773	.825	.866	.921	.938	.961	.962	.969	1.976.	.1.973	v.g.−
Aug. 1	5.4	10.0	1.359	.641	.712	.801	.852	.895	.948	.961	.971	.972	.973	1.940	1.936	v.g.+
6	7.3	17.3	1.307	.589	.685	.776	.832	.884	.936	.954	.976	.974	.975	1.948	1.956	e.−

TABLE 29b.—*Solar-constant values. Long method. Table Mountain, 1925–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46, 0.348 μ	38, 0.391 μ	32, 0.446 μ	28, 0.497 μ	22, 0.615 μ	19, 0.724 μ	17, 0.817 μ	14, 0.994 μ	11, 1.225 μ	6, 1.600 μ	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1929	*Mm*	*Mm*														
Aug. 7	6.8	12.0	1.348	0.627	0.722	0.811	0.863	0.904	0.955	0.966	0.977	0.976	0.977	1.907	1.906	e.—
9	3.0	2.1	1.446	.647	.726	.812	.866	.903	.955	.966	.973	.972	.980	1.905	1.906	e.
12	6.4	14.5	1.228	.578	.660	.757	.813	.865	.925	.945	.967	.969	.971	1.866	1.870	v.g.—
15	9.0	21.6	1.266	.596	.684	.777	.837	.889	.941	.957	.975	.978	.978	1.909	1.929	v.g.+
19	8.3	20.6	1.228	.595	.665	.757	.819	.880	.931	.947	.961	.961	.965	1.900	1.920	v.g.+
20	9.0	15.5	1.291	.623	.702	.806	.850	.895	.947	.958	.972	.972	.976	1.883	1.889	v.g.
29	9.7	20.5	1.243	.585	.672	.765	.827	.880	.936	.956	.971	.972	.974	1.885	1.905	v.g.
30	8.1	17.0	1.308	.606	.718	.801	.863	.902	.956	.968	.977	.978	.984	1.876	1.884	v.g.—
Sept. 3	6.1	3.4	1.443	.632	.726	.815	.864	.904	.953	.967	.977	.975	.980	1.926	1.927	e.—
5	3.9	4.1	1.424	.615	.725	.812	.864	.903	.949	.964	.975	.976	.982	1.916	1.917	e.
8	4.6	4.0	1.377	.600	.686	.791	.832	.877	.931	.948	.958	.958	.966	1.928	1.929	e.—
12	6.4	9.9	1.332	.638	.716	.802	.856	.903	.949	.962	.972	.973	.979	1.889	1.885	v.g.+
16	4.3	4.4	1.295	.550	.646	.732	.796	.852	.912	.934	.954	.958	.968	1.941	1.942	g.+
22	2.1	2.2	1.420	.635	.722	.812	.864	.904	.953	.964	.976	.975	.980	1.885	1.886	e.
23	2.1	3.0	1.446	.635	.730	.818	.868	.907	.960	.973	.979	.980	.981	1.909	1.910	e.
26	1.1	2.3	1.460	.655	.726	.818	.868	.908	.954	.966	.976	.976	.980	1.931	1.932	e.
Oct. 8	2.8	3.2	1.440	.630	.722	.821	.864	.902	.954	.967	.977	.977	.980	1.922	1.923	e.—
9	2.6	4.5	1.422	.640	.722	.812	.866	.906	.954	.966	.974	.976	.980	1.909	1.910	e.
10	4.0	4.7	1.400	.623	.712	.796	.855	.893	.948	.959	.970	.973	.978	1.924	1.925	e.
11	3.9	5.1	1.397	.625	.712	.796	.853	.894	.944	.958	.969	.970	.978	1.938	1.939	e.
16	4.7	7.9	-------	.611	.687	.780	.936	.888	.944	.958	.972	.972	.980	1.918	1.915	v.g.
27	1.6	2.7	-------	.651	.726	.815	.867	.906	.962	.968	.979	.980	.982	1.900	1.901	e.
29	2.1	2.2	1.397	.615	.702	.791	.946	.890	.947	.962	.973	.975	.981	1.881	1.882	v.g.+
[1] Nov. 1	1.4	3.6	1.440	.632	.733	.816	.873	.911	.958	.968	.980	.986	.987	1.909	1.910	e.
9	1.3	3.6	1.432	.660	.728	.830	.868	.908	.955	.968	.980	.980	.983	1.900	1.901	e.
12	1.8	1.0	1.486	.652	.730	.812	.867	.905	.956	.967	.975	.976	.981	1.923	1.923	e.
13	1.7	1.4	1.481	.666	.720	.811	.865	.902	.953	.965	.974	.974	.982	1.941	1.941	e.
14	1.5	3.4	1.450	.631	.726	.815	.868	.911	.956	.968	.979	.978	.981	1.937	1.938	e.
16	2.1	2.0	1.483	.649	.731	.824	.872	.910	.960	.968	.978	.978	.984	1.940	1.941	e.
19	1.3	2.4	1.473	.651	.732	.824	.873	.914	.960	.969	.978	.978	.985	1.930	1.931	e.
26	2.9	4.1	1.430	.635	.722	.811	.863	.907	.951	.964	.975	.978	.978	1.921	1.922	e.—
Dec. 1	2.4	3.6	1.462	.660	.736	.822	.876	.917	.958	.971	.982	.982	.984	1.924	1.925	e.—
2	2.3	3.1	1.460	.635	.732	.822	.872	.912	.961	.971	.979	.979	.986	1.917	1.918	e.—
5	2.4	4.0	1.458	.635	.721	.808	.862	.901	.948	.966	.976	.976	.978	1.950	1.951	v.g.+
11	3.1	2.3	-------	.660	.735	.824	.869	.912	.959	.970	.979	.981	.984	1.916	1.917	e.—
20	2.5	1.9	1.475	.641	.727	.818	.870	.907	.956	.968	.978	.977	.981	1.918	1.918	v.g.+
21	1.4	2.0	1.473	.644	.731	.816	.874	.914	.958	.970	.981	.981	.985	1.923	1.924	e.—
23	1.4	1.4	1.487	.640	.726	.816	.864	.897	.955	.968	.979	.980	.985	1.937	1.937	e.
26	1.9	1.3	1.481	.648	.732	.814	.871	.904	.956	.966	.976	.976	.979	1.912	1.912	e.—
31	1.5	2.3	1.453	.678	.729	.815	.863	.906	.956	.969	.979	.976	.984	1.914	1.915	e.—
1930																
Jan. 8	1.8	1.7	1.441	.631	.712	.805	.847	.882	.943	.956	.968	.973	.978	1.946	1.946	v.g.+
17	3.6	3.1	1.460	.649	.728	.826	.871	.914	.956	.968	.980	.980	.983	1.928	1.929	e.—
19	3.0	4.5	1.413	.645	.730	.816	.869	.902	.958	.969	.974	.976	.983	1.904	1.905	v.g.
30	2.6	4.9	1.432	.615	.716	.812	.863	.898	.950	.963	.975	.976	.981	1.953	1.954	v.g.+
Feb. 3	3.5	2.4	1.432	.657	.732	.816	.863	.903	.954	.966	.976	.976	.984	1.903	1.904	e.—
7	2.8	2.6	1.467	.648	.725	.821	.867	.907	.960	.971	.980	.983	.986	1.933	1.934	e.
8	3.2	2.6	1.474	.636	.744	.815	.869	.909	.961	.973	.981	.979	.982	1.924	1.925	v.g.+
10	2.5	2.1	1.469	.638	.721	.821	.869	.903	.960	.971	.980	.980	.982	1.908	1.909	e.—
12	2.9	3.9	-------	.652	.731	.822	.873	.914	.959	.972	.980	.983	.985	1.931	1.932	e.
15	4.0	4.4	1,441	.653	.735	.814	.868	.912	.958	.967	.976	.975	.977	1.935	1.936	v.g.+
17	3.1	2.0	1.471	.664	.726	.816	.869	.912	.958	.969	.979	.980	.984	1.917	1.918	e.—
28	1.3	0.5	1.486	.615	.715	.806	.853	.892	.944	.959	.972	.973	.981	1.944	1.944	v.g.+
Mar. 8	2.5	2.8	1.355	.621	.696	.784	.838	.874	.931	.944	.957	.959	.967	1.905	1.906	v.g.+
11	2.8	2.5	1.370	.606	.691	.777	.828	.872	.935	.945	.962	.968	.975	1.914	1.915	e.—
12	2.6	1.7	1.371	.610	.681	.765	.822	.863	.917	.929	.944	.953	.965	1.955	1.955	v.g.
19	3.5	3.1	1.413	.637	.710	.797	.842	.882	.942	.956	.966	.971	.974	1.953	1.954	v.g.+
21	3.2	4.9	1.415	.645	.721	.808	.864	.906	.954	.968	.976	.976	.980	1.940	1.941	e.—
25	3.9	3.0	1.459	.630	.731	.821	.867	.910	.959	.972	.977	.977	.982	1.936	1.937	e.—
26	3.3	2.4	1.449	.650	.720	.805	.862	.900	.952	.965	.972	.972	.980	1.936	1.937	e.—
27	3.1	3.6	1.409	.600	.715	.812	.862	.899	.951	.965	.974	.974	.982	1.909	1.910	e.—
Apr. 4	2.6	1.3	1.475	.629	.720	.806	.860	.898	.951	.963	.976	.976	.981	1.942	1.942	e.—

[1] From Nov., 1929, to Dec., 1930, inclusive, values in columns 4, 15, and 16 should be increased by 0.4 per cent.

TABLE 29*b*.—*Solar-constant values. Long method. Table Mountain, 1925–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				46 0.348 μ	38 0.391 μ	32 0.446 μ	28 0.497 μ	22 0.615 μ	19 0.724 μ	17 0.817 μ	14 0.994 μ	11 1.225 μ	6 1.600 μ			
1930	*Mm*	*Mm*														
Apr. 5	4.2	1.5	1.476	0.641	0.721	0.805	0.860	0.897	0.952	0.964	0.975	0.975	0.979	1.946	1.946	e.−
7	3.3	5.5	1.428	.647	.727	.824	.872	.913	.959	.971	.980	.979	.984	1.925	1.926	e.−
11	2.4	5.3	-------	.639	.731	.815	.867	.905	.953	.970	.972	.975	.979	1.924	1.925	v.g.+
17	3.0	2.4	1.381	.623	.710	.795	.847	.880	.936	.947	.960	.961	.966	1.900	1.901	v.g.
18	2.7	5.0	1.330	.626	.695	.782	.834	.864	.917	.931	.945	.951	.958	1.945	1.946	v.g.
24	3.4	2.2	1.269	.605	.678	.751	.789	.822	.889	.900	.914	.922	.930	1.936	1.937	g.+
May 10	3.9	2.8	1.430	.641	.716	.802	.859	.894	.951	.963	.975	.976	.983	1.907	1.908	e.−
11	4.1	4.7	1.365	.625	.712	.804	.857	.888	.943	.955	.967	.971	.979	1.877	1.878	v.g.+
13	2.0	1.7	1.441	.621	.720	.815	.861	.892	.949	.962	.973	.974	.981	1.904	1.904	e.
24	3.9	2.3	1.376	.612	.709	.791	.842	.877	.930	.942	.956	.955	.963	1.922	1.923	e.−
28	3.2	4.8	1.431	.633	.727	.817	.862	.898	.954	.963	.974	.972	.978	1.942	1.943	e.
31	3.7	3.4	1.416	.624	.709	.797	.850	.883	.935	.950	.961	.962	.971	1.969	1.970	v.g.−
June 5	5.4	3.9	-------	.617	.701	.791	.839	.877	.933	.947	.962	.967	.974	1.921	1.922	e.
9	3.1	2.2	1.457	.630	.732	.820	.867	.904	.955	.967	.977	.978	.983	1.912	1.913	e.−
12	7.0	8.4	1.383	.637	.722	.805	.859	.899	.951	.966	.977	.976	.980	1.921	1.917	e.−
14	5.8	6.9	1.388	.641	.722	.820	.868	.905	.955	.969	.978	.978	.979	1.904	1.903	e.−
15	5.8	6.0	1.402	.628	.722	.805	.857	.896	.945	.961	.973	.975	.974	1.938	1.938	e.−
16	5.6	7.5	1.361	.630	.708	.792	.850	.889	.942	.955	.967	.965	.974	1.935	1.933	e.
18	5.1	6.3	1.417	.635	.733	.822	.869	.908	.957	.968	.977	.979	.981	1.932	1.929	e.−
23	2.2	2.9	1.452	.635	.730	.815	.871	.903	.956	.967	.976	.977	.980	1.934	1.935	e.
24	3.2	2.2	1.479	.626	.735	.821	.869	.904	.956	.966	.979	.979	.981	1.965	1.966	v.g.+
28	2.8	1.6	1.505	.647	.737	.831	.880	.917	.965	.976	.983	.981	.986	1.925	1.925	e.−
July 1	2.9	6.1	1.429	.642	.730	.816	.868	.907	.956	.969	.976	.975	.980	1.946	1.946	e.
10	4.1	10.0	1.359	.639	.715	.803	.858	.898	.950	.967	.975	.975	.977	1.923	1.919	e.−
11	5.2	11.1	1.330	.610	.701	.795	.847	.890	.942	.955	.967	.969	.971	1.934	1.931	e.−
12	5.2	12.4	1.354	.616	.714	.805	.854	.899	.946	.958	.969	.969	.970	1.939	1.938	v.g.−
17	6.3	17.9	1.315	.611	.700	.786	.842	.890	.942	.959	.974	.971	.970	1.950	1.960	e.−
19	2.1	9.0	1.397	.621	.725	.815	.866	.907	.956	.969	.982	.982	.983	1.927	1.923	v.g.+
21	3.2	3.5	1.451	.636	.733	.821	.875	.910	.963	.975	.981	.986	.986	1.912	1.913	v.g.+
23	1.8	7.5	1.416	.625	.732	.822	.873	.914	.959	.971	.983	.983	.986	1.925	1.922	v.g.+
25	4.4	6.3	1.436	.633	.732	.824	.875	.912	.965	.979	.986	.984	.984	1.929	1.929	e.
Aug. 5	8.1	17.4	1.324	.641	.726	.828	.868	.904	.957	.972	.980	.980	.979	1.894	1.904	v.g.+
10	5.0	10.0	1.403	.650	.731	.822	.872	.906	.957	.970	.980	.981	.984	1.934	1.930	v.g.+
11	5.6	10.4	1.385	.640	.738	.829	.872	.913	.963	.976	.982	.980	.984	1.901	1.898	v.g.
12	6.5	15.7	1.295	.615	.705	.801	.854	.896	.950	.965	.977	.976	.977	1.903	1.909	v.g.−
16	1.9	3.0	1.476	.642	.741	.834	.880	.916	.967	.975	.985	.985	.987	1.921	1.922	e.
18	2.4	3.7	1.461	.640	.735	.827	.877	.913	.965	.977	.985	.985	.987	1.897	1.898	e.−
25	8.5	20.3	1.238	.550	.646	.741	.806	.864	.922	.944	.959	.962	.965	1.966	1.986	v.g.
26	5.1	10.9	1.406	.646	.736	.827	.879	.915	.965	.976	.988	.985	.985	1.918	1.915	e.−
28	2.8	7.7	1.426	.650	.741	.824	.875	.912	.962	.975	.981	.980	.982	1.933	1.930	v.g.+
Sept. 3	5.7	10.7	1.391	.610	.716	.819	.863	.904	.957	.971	.981	.980	.980	1.945	1.942	e.−
5	6.5	11.3	1.400	.642	.733	.820	.876	.914	.960	.972	.983	.981	.980	1.901	1.899	v.g.+
8	3.3	8.2	1.431	.633	.732	.821	.876	.911	.963	.973	.981	.982	.981	1.923	1.919	v.g.+
10	2.0	3.1	1.453	.630	.723	.815	.867	.904	.954	.957	.976	.975	.979	1.947	1.948	e.
11	3.6	3.2	1.436	.640	.738	.821	.879	.916	.965	.973	.981	.980	.983	1.895	1.896	v.g.+
15	3.2	4.5	1.436	.626	.735	.819	.872	.914	.960	.974	.980	.982	.986	1.911	1.912	e.−
17	1.6	11.6	1.411	.646	.739	.830	.880	.915	.962	.976	.985	.981	.983	1.927	1.925	v.g.+
22	3.0	5.6	1.416	.622	.723	.811	.863	.902	.953	.968	.976	.977	.978	1.934	1.934	e.−
23	2.5	9.3	-------	.645	.734	.816	.868	.904	.956	.969	.981	.982	.982	1.948	1.944	v.g.+
Oct. 10	3.5	3.7	-------	.646	.734	.818	.867	.903	.955	.971	.981	.981	.985	1.905	1.906	v.g.+
11	2.6	3.8	1.458	.640	.730	.822	.873	.909	.963	.973	.982	.978	.981	1.927	1.928	e.
13	3.6	3.4	1.448	.626	.726	.815	.872	.910	.958	.970	.981	.981	.983	1.922	1.923	e.
15	2.1	2.3	1.490	.660	.739	.830	.879	.915	.963	.975	.983	.983	.985	1.926	1.927	e.
16	3.2	3.7	1.453	.642	.737	.827	.875	.913	.962	.974	.985	.983	.982	1.924	1.925	e.
19	2.7	3.5	1.463	.651	.736	.822	.876	.914	.961	.973	.981	.979	.980	1.935	1.936	e.−
21	1.3	3.2	1.475	.646	.736	.832	.882	.916	.963	.974	.985	.985	.986	1.920	1.921	e.
24	2.4	2.5	1.473	.666	.742	.832	.877	.913	.964	.975	.984	.986	.982	1.916	1.917	v.g.+
31	1.6	2.4	1.486	.651	.741	.828	.881	.915	.962	.973	.980	.981	.981	1.901	1.901	v.g.+
Nov. 3	1.7	2.7	1.456	.646	.730	.817	.869	.907	.954	.968	.981	.981	.983	1.935	1.936	e.−
4	2.1	3.3	1.456	.622	.719	.808	.857	.898	.951	.966	.977	.977	.979	1.943	1.944	v.g.+
6	3.4	6.8	1.414	.625	.721	.815	.863	.903	.960	.969	.981	.983	.983	1.921	1.920	e.−
8	3.3	4.1	1.431	.628	.717	.807	.857	.896	.946	.961	.974	.975	.974	1.952	1.953	v.g.+
11	2.7	3.1	1.460	.635	.733	.819	.876	.914	.962	.972	.981	.983	.984	1.933	1.934	e.−
19	1.2	3.0	1.478	.656	.741	.829	.878	.919	.963	.975	.984	.984	.985	1.918	1.919	e.

TABLE 29*b*.—*Solar-constant values. Long method. Table Mountain, 1925–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46 (0.348 μ)	38 (0.391 μ)	32 (0.446 μ)	28 (0.497 μ)	22 (0.615 μ)	19 (0.724 μ)	17 (0.817 μ)	14 (0.994 μ)	11 (1.225 μ)	6 (1.600 μ)	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1930	*Mm*	*Mm*														
Nov. 20	2.0	1.4	1.511	0.640	0.736	0.831	0.879	0.921	0.966	0.976	0.982	0.983	0.985	1.932	1.932	e.
21	2.8	3.1	1.471	.662	.732	.820	.873	.915	.960	.976	.986	.985	.986	1.921	1.922	e.−
25	2.5	5.3	1.441	.635	.728	.821	.870	.914	.961	.973	.983	.985	.982	1.946	1.947	e.−
Dec. 1	1.2	1.2	-------	.664	.736	.821	.886	.929	.968	.977	.988	.988	.988	1.899	1.899	v.g.−
2	1.1	3.8	1.492	.670	.732	.821	.874	.906	.962	.972	.983	.984	.987	1.934	1.935	v.g.+
3	2.7	2.4	1.475	.650	.736	.826	.873	.913	.962	.973	.984	.985	.986	1.927	1.928	e.
7	2.1	2.8	1.472	.667	.732	.824	.870	.906	.959	.971	.981	.981	.981	1.941	1.942	e.−
11	1.4	4.1	1.460	.665	.740	.832	.879	.919	.964	.974	.982	.982	.984	1.922	1.923	e.−
17	1.7	0.8	1.521	.647	.736	.834	.876	.911	.963	.976	.983	.985	.987	1.928	1.928	e.
18	2.2	2.1	-------	.662	.735	.825	.870	.903	.959	.970	.978	.978	.980	1.929	1.930	v.g.−
27	2.0	2.0	-------	.647	.740	.826	.874	.909	.962	.971	.982	.982	.983	1.920	1.920	e.−

TABLE 30.—*Solar-constant values. Long method. Mount Brukkaros, 1926–1930*

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46 (0.348 μ)	38 (0.391 μ)	32 (0.446 μ)	28 (0.497 μ)	22 (0.615 μ)	19 (0.705 μ)	17 (0.789 μ)	14 (0.958 μ)	11 (1.189 μ)	6 (1.603 μ)	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1926	*Mm*	*Mm*														
Dec. 9	------	11.7	-------	0.591	0.711	0.802	0.853	0.889	0.928	0.949	0.955	0.955	0.965	1.918	1.925	p.+
10	4.3	10.8	1.356	.582	.714	.801	.858	.897	.944	.958	.971	.972	.969	1.921	1.927	g.
1927																
Jan. 5	4.2	12.2	1.360	.598	.721	.802	.863	.901	.946	.965	.967	.964	.982	1.918	1.925	g.−
6	5.7	15.7	1.361	.599	.730	.842	.876	.912	.957	.979	.988	.989	.995	1.874	1.887	g.˙
7	3.1	6.5	1.396	.586	.715	.796	.854	.898	.945	.962	.970	.973	.967	1.936	1.934	g.
8	2.4	4.8	1.409	.573	.705	.809	.853	.889	.944	.956	.970	.970	.978	1.944	1.940	g.
Feb. 2	4.4	12.5	1.348	.578	.718	.782	.864	.904	.949	.970	.978	.979	.987	1.906	1.913	g.
3	5.6	13.5	1.321	.569	.706	.778	.850	.888	.930	.945	.958	.957	.968	1.915	1.925	g.
Mar. 13	3.0	9.4	1.387	.593	.723	.837	.870	.911	.959	.976	.985	.985	.987	1.887	1.890	g.−
14	3.3	9.5	1.494	.585	.718	.792	.867	.909	.951	.969	.981	.979	.980	1.919	1.920	g.−
22	4.3	16.1	1.360	.580	.710	.808	.855	.900	.942	.965	.975	.973	.980	1.928	1.941	g.
Apr. 4	10.9	22.3	1.338	.597	.699	.797	.860	.896	.955	.968	.977	.976	.976	1.954	1.976	g.−
18	3.4	6.5	1.445	.580	.715	.807	.864	.905	.958	.975	.984	.984	.990	1.962	1.962	g.
26	4.3	8.1	1.396	.600	.702	.796	.853	.892	.943	.958	.970	.972	.977	1.957	1.958	g.
27	4.3	14.4	1.356	.583	.704	.790	.849	.894	.952	.966	.973	.972	.966	1.939	1.949	g.
29	3.3	9.7	1.405	.587	.711	.801	.871	.909	.961	.975	.985	.983	.980	1.923	1.927	g.+
May 7	2.4	7.2	1.411	.587	.707	.796	.857	.904	.949	.965	.978	.976	.978	1.948	1.948	g.+
8	2.5	8.0	1.403	.572	.696	.799	.855	.904	.949	.964	.975	.975	.970	1.956	1.957	g.
10	4.7	13.9	1.418	.566	.686	.786	.849	.897	.942	.958	.972	.975	.974	1.886	1.896	g.
13	3.4	3.7	1.448	.568	.711	.790	.861	.905	.955	.970	.982	.978	.980	1.946	1.940	g.
15	2.5	6.8	1.437	.589	.714	.797	.864	.907	.958	.972	.983	.984	.979	1.948	1.948	g.
17	4.5	5.6	1.443	.580	.711	.801	.867	.902	.954	.967	.979	.980	.979	1.959	1.957	g.+
18	4.0	3.8	1.457	.565	.710	.783	.859	.900	.950	.965	.975	.975	.982	1.961	1.956	g.
19	3.1	7.7	1.395	.592	.701	.795	.858	.902	.944	.962	.974	.974	.978	1.945	1.946	g.−
20	3.8	8.8	1.376	.575	.694	.767	.844	.896	.940	.958	.971	.973	.978	1.945	1.948	g.−
22	2.6	5.9	1.416	.583	.708	.803	.859	.907	.950	.965	.979	.980	.983	1.920	1.918	g.+
30	4.4	11.7	1.292	.522	.653	.741	.811	.868	.927	.947	.970	.975	.983	1.934	1.941	g.
31	5.0	11.1	1.313	.530	.652	.743	.814	.869	.923	.949	.970	.973	.979	1.966	1.972	g.
June 1	4.4	12.4	1.276	.527	.644	.743	.804	.869	.919	.945	.963	.971	.984	1.922	1.929	g.
5	4.7	9.0	1.395	.565	.707	.776	.845	.888	.931	.948	.961	.968	.970	1.966	1.969	g.−
10	3.9	8.0	1.348	.549	.685	.757	.830	.887	.937	.958	.973	.975	.980	1.928	1.929	g.−
11	3.6	8.6	1.360	.553	.655	.759	.816	.884	.933	.956	.974	.979	.985	1.958	1.960	g.−
16	2.6	8.4	1.366	.585	.715	.796	.862	.903	.952	.971	.985	.986	.986	1.901	1.902	g.−
17	3.3	9.2	1.334	.552	.679	.759	.837	.892	.938	.958	.974	.976	.980	1.921	1.924	g.−
18	2.8	7.9	1.344	.581	.673	.751	.827	.891	.936	.957	.971	.978	.987	1.933	1.934	g.−

TABLE 30.—*Solar-constant values. Long method. Mount Brukkaros, 1926–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths: Place and wave length										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				46 0.348 μ	38 0.391 μ	32 0.446 μ	28 0.497 μ	22 0.615 μ	19 0.705 μ	17 0.789 μ	14 0.958 μ	11 1.189 μ	6 1.603 μ			
1927	*Mm*	*Mm*														
June 19	4.4	8.8	1.339	0.556	0.670	0.760	0.824	0.884	0.931	0.959	0.965	0.971	0.978	1.948	1.951	g.
20	3.6	6.5	1.408	.535	.680	.770	.841	.894	.939	.958	.972	.972	.980	1.998	1.996	g.
21	3.8	9.7	1.357	.566	.690	.768	.835	.892	.936	.958	.970	.973	.982	1.957	1.961	g.
25	3.8	6.4	1.349	.555	.650	.761	.820	.882	.935	.955	.974	.980	.987	1.919	1.917	g.–
July 2	3.0	3.4	1.429	.580	.706	.771	.845	.903	.953	.967	.982	.985	.986	1.948	1.942	p.+
3	2.9	3.7	1.436	.577	.706	.791	.885	.907	.952	.970	.984	.988	.990	1.927	1.922	g.
4	2.8	4.2	1.422	.588	.711	.795	.857	.910	.953	.969	.980	.985	.982	1.932	1.925	g.
5	2.9	6.4	1.322	.525	.628	.737	.801	.869	.922	.945	.965	.974	.982	1.949	1.947	g.+
7	3.5	4.5	1.411	.588	.699	.787	.848	.899	.949	.965	.979	.985	.989	1.923	1.918	g.–
8	2.7	7.0	1.241	.480	.586	.706	.756	.833	.897	.922	.952	.967	.979	1.951	1.951	g.–
10	5.7	9.4	1.251	.543	.632	.716	.791	.856	.913	.937	.965	.972	.986	1.882	1.885	g.
11	3.7	6.0	1.372	.506	.670	.762	.827	.881	.932	.952	.973	.983	.989	1.939	1.937	g.–
13	5.1	5.6	1.418	.550	.691	.792	.850	.904	.945	.964	.976	.979	.980	1.957	1.955	g.
14	4.9	4.1	1.457	.539	.702	.783	.852	.903	.949	.966	.979	.981	.985	1.981	1.976	g.
15	3.9	3.9	1.455	.534	.710	.796	.863	.909	.954	.970	.984	.986	.992	1.957	1.952	g.
16	3.0	3.3	1.462	.584	.716	.792	.858	.909	.954	.970	.982	.984	.989	1.948	1.942	g.
17	2.7	4.9	1.435	.576	.696	.792	.859	.899	.949	.968	.981	.983	.988	1.965	1.961	g.
23	3.9	9.7	1.387	.565	.697	.784	.853	.894	.945	.964	.977	.980	.985	1.959	1.963	g.
25	3.3	6.9	1.433	.573	.715	.799	.856	.910	.957	.974	.983	.985	.988	1.942	1.942	g.
26	3.5	6.8	1.420	.575	.689	.784	.844	.895	.947	.965	.978	.981	.988	1.981	1.981	g.+
27	4.5	6.0	1.421	.573	.702	.796	.855	.910	.949	.967	.979	.981	.986	1.968	1.966	g.+
28	4.4	8.6	1.395	.556	.704	.800	.845	.898	.945	.965	.977	.980	.984	1.961	1.964	g.
Aug. 3	4.6	6.6	1.359	.526	.656	.742	.802	.863	.917	.943	.965	.974	.982	2.010	2.010	g.–
5	3.8	6.9	1.359	.575	.693	.773	.840	.887	.938	.958	.975	.977	.981	1.919	1.919	g.
6	4.0	4.6	1.428	.581	.705	.789	.856	.898	.956	.972	.982	.985	.987	1.938	1,934	g.–
7	4.4	4.8	1.440	.576	.712	.796	.858	.903	.950	.967	.980	.980	.990	1.949	1.953	v.g.
28	2.0	2.4	1.466	.548	.699	.782	.848	.894	.947	.967	.980	.983	.986	1.967	1.959	g.
29	0.7	3.4	1.455	.581	.699	.794	.848	.896	.946	.967	.979	.983	.987	1.963	1.957	g.
30	5.1	10.1	1.393	.563	.682	.779	.842	.894	.945	.963	.976	.980	.990	1.985	1.989	g.
31	4.4	6.8	1.422	.588	.706	.797	.853	.898	.948	.960	.977	.973	.978	1.980	1.980	p.+
Sept. 1	3.2	6.9	1.418	.569	.702	.781	.856	.897	.944	.965	.978	.976	.986	1.969	1.969	g.
16	2.3	2.3	1.469	.574	.707	.800	.861	.904	.958	.972	.985	.986	.992	1.925	1.917	g.+
17	0.9	3.0	1.465	.590	.718	.805	.861	.904	.952	.971	.981	.981	.987	1.938	1.932	g.
22	4.0	11.0	1.326	.544	.672	.759	.827	.877	.929	.951	.965	.972	.985	1.930	1.936	g.
23	3.0	12.1	1.299	.543	.678	.766	.826	.869	.919	.941	.955	.956	.967	1.921	1.928	g.
30	2.9	11.2	1.262	.503	.626	.725	.775	.840	.898	.922	.944	.953	.958	1.969	1.973	g.
Oct. 8	2.1	4.2	-------	.571	.705	.786	.858	.900	.949	.962	.978	.978	.988	1.950	1.945	g.
Nov. 2	3.0	12.7	1.333	.563	.698	.788	.848	.889	.938	.956	.965	.965	.979	1.936	1.945	g.
3	2.5	8.9	1.359	.580	.706	.796	.854	.894	.937	.956	.968	.966	.971	1.934	1.937	g.
10	2.7	8.3	1.406	.592	.711	.803	.860	.904	.942	.965	.978	.982	.986	1.941	1.942	g.+
13	2.6	8.7	1.380	.581	.706	.795	.855	.894	.940	.957	.968	.970	.975	1.949	1.950	g.
Dec. 9	3.9	13.3	1.337	.574	.697	.788	.843	.888	.927	.942	.955	.953	.956	1.969	1.978	g.
30	6.0	19.0	1.315	.594	.702	.794	.853	.897	.942	.962	.970	.970	.973	1.920	1.938	g.
1928																
Jan. 28	2.6	8.6	1.374	.596	.715	.803	.861	.904	.950	.967	.981	.982	.981	1.899	1.902	g.+
30	4.6	14.8	1.334	.573	.707	.795	.852	.896	.937	.954	.964	.965	.965	1.943	1.955	g.–
Feb. 15	3.1	8.4	1.371	.596	.716	.800	.864	.904	.952	.969	.982	.983	.987	1.884	1.885	g.
Mar. 30	4.5	11.9	1.364	.583	.711	.802	.860	.906	.947	.962	.970	.971	.971	1.931	1.938	g.
31	5.1	11.7	1.378	.572	.722	.801	.866	.907	.949	.966	.976	.979	.976	1.932	1.939	g.–
Apr. 2	5.8	14.4	1.358	.592	.711	.795	.856	.897	.943	.960	.970	.973	.972	1.960	1.970	g.
25	5.8	15.7	1.338	.570	.701	.793	.857	.896	.948	.967	.980	.978	.980	1.926	1.939	g.–
26	5.8	13.1	1.363	.598	.702	.792	.850	.897	.941	.962	.977	.975	.981	1.953	1.962	g.
27	4.3	10.1	1.377	.583	.702	.807	.859	.905	.952	.970	.981	.980	.985	1.924	1.928	g.+
28	4.5	11.1	1.379	.594	.706	.794	.858	.906	.952	.968	.979	.976	.980	1.940	1.946	g.+
May 8	4.2	12.5	1.364	.591	.684	.794	.854	.899	.950	.967	.973	.970	.978	1.956	1.963	g.–
9	5.1	12.7	1.341	.614	.709	.803	.862	.903	.943	.960	.972	.977	.980	1.916	1.925	g.–
13	4.1	10.2	1.391	.614	.703	.793	.859	.906	.959	.971	.984	.983	.985	1.935	1.939	g.–
16	4.1	10.0	1.375	.586	.704	.794	.854	.908	.949	.967	.977	.980	.980	1.933	1.937	g.
26	2.3	11.6	1.349	.584	.698	.779	.845	.894	.945	.963	.977	.979	.985	1.927	1.934	g.
27	1.6	9.7	1.360	.590	.684	.773	.836	.885	.938	.959	.973	.979	.980	1.953	1.957	g.
June 12	4.5	8.1	1.411	.624	.716	.811	.872	.914	.960	.976	.986	.993	.986	1.918	1.919	g.–
13	3.9	5.7	1.430	.611	.720	.794	.867	.909	.956	.973	.983	.984	.985	1.948	1.946	g.–
16	2.6	5.0	1.406	.626	.684	.776	.844	.904	.944	.967	.978	.981	.988	1.957	1.953	g.
18	2.3	4.1	1.432	.643	.706	.791	.866	.908	.955	.971	.983	.985	.990	1.924	1.919	g.

TABLE 30.—*Solar-constant values. Long method. Mount Brukkaros, 1926–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths — Place and wave length: 46, 0.348 μ	38, 0.391 μ	32, 0.446 μ	28, 0.497 μ	22, 0.615 μ	19, 0.705 μ	17, 0.789 μ	14, 0.958 μ	11, 1.189 μ	6, 1.603 μ	Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
1928	*Mm*	*Mm*														
July 18	2.5	4.0	1.376	0.576	0.674	0.763	0.827	0.887	0.935	0.953	0.970	0.974	0.977	1.948	1.943	g.+
30	3.3	4.1	1.401	.583	.695	.786	.846	.893	.942	.962	.978	.978	.981	1.939	1.934	g.
Aug. 7	4.4	4.2	1.398	.548	.676	.776	.840	.888	.940	.962	.972	.981	.990	1.952	1.947	g.−
8	3.4	2.6	1.460	.596	.715	.802	.864	.910	.955	.971	.983	.980	.982	1.940	1.934	g.
9	4.2	4.2	1.435	.582	.710	.802	.867	.906	.950	.968	.979	.980	.981	1.946	1.941	g.
20	3.1	3.5	1.440	.598	.715	.806	.868	.908	.957	.970	.981	.984	.986	1.917	1.912	g.−
22	2.0	4.3	1.403	.549	.663	.762	.834	.876	.940	.961	.974	.981	.984	1.950	1.945	g.
30	4.2	5.6	1.356	.558	.675	.767	.834	.886	.935	.953	.966	.971	.977	1.937	1.935	g.
31	3.4	6.8	1.190	.503	.589	.652	.741	.821	.894	.926	.954	.965	.973	1.920	1.920	p.+
Sept. 10	4.1	10.3	1.284	.519	.641	.730	.804	.864	.919	.940	.964	.969	.979	1.957	1.961	g.
13	3.7	2.9	1.435	.584	.699	.791	.851	.905	.954	.967	.982	985	.984	1.925	1.919	g.
17	3.1	3.9	1.413	.585	.704	.802	.853	.897	.949	.967	.981	.980	.981	1.917	1.912	g.
Oct. 1	4.0	5.2	1.419	.593	.701	.806	.862	.907	.955	.974	.980	.988	.989	1.914	1.910	g.−
2	3.9	8.0	1.354	.567	.693	.779	.847	.894	.944	.963	.980	.981	.987	1.923	1.924	g.
4	3.1	4.4	1.402	.603	.698	.790	.846	.897	.945	.962	.978	.979	.984	1.860	1.855	g.+
26	3.8	5.5	1.382	.530	.660	.758	.827	.885	.936	.952	.970	.970	.969	1.985	1.983	g.−
27	3.6	6.5	1.392	.582	.700	.792	.855	.902	.950	.969	.979	.981	.985	1.926	1.926	g.+
Nov. 13	3.3	9.0	1.368	.592	.711	.786	.850	.899	.947	.957	.965	.966	.967	1.932	1.935	g.
Dec. 28	5.7	13.2	1.352	.584	.706	.778	.856	.901	.936	.956	.967	.966	.965	1.927	1.936	g.
30	5.3	10.4	1.353	.613	.715	.800	.861	.904	.947	.966	.977	.979	.976	1.891	1.895	g.
1929																
Jan. 2	4.4	7.0	1.358	.612	.714	.794	.847	.894	.939	.956	.967	.967	.972	1.912	1.912	g.
14	4.5	9.2	1.317	.577	.694	.793	.849	.888	.937	.951	.962	.962	.968	1.912	1.915	g.
Feb. 16	5.8	15.2	1.327	.570	.706	.786	.853	.889	.937	.950	.963	.965	.969	1.933	1.945	g.
17	4.3	9.8	1.341	.585	.707	.784	.843	.882	.928	.944	.956	.960	.966	1.952	1.956	g.−
18	3.2	6.6	1.407	.600	.713	.787	.863	.909	.955	.968	.978	.982	.980	1.922	1.922	g.
21	5.4	10.4	1.469	.578	.689	.760	.852	.891	.947	.966	.974	.983	.981	1.910	1.914	g.
22	6.5	15.0	1.310	.585	.708	.766	.853	.894	.938	.958	.971	.975	.974	1.926	1.938	p.+
Mar. 16	4.8	8.6	1.364	.583	.704	.803	.856	.897	.944	.963	.974	.974	.985	1.924	1.927	g.
18	5.9	15.3	1.318	.584	.704	.798	.856	.903	.946	.962	.974	.975	.981	1.882	1.894	g.
Apr. 8	5.9	18.1	1.314	.545	.700	.788	.856	.909	.948	.967	.981	.981	.978	1.911	1.928	g.−
20	4.2	10.2	1.375	.568	.701	.799	.856	.899	.947	.970	.982	.985	.987	1.908	1.912	p.+
29	7.1	5.0	1.436	.575	.704	.796	.861	.905	.954	.971	.983	.983	.989	1.933	1.929	g.
30	5.5	12.5	1.356	.581	.708	.791	.863	.907	.952	.971	.980	.985	.985	1.900	1.907	g.
May 8	5.4	16.0	1.312	.559	.683	.775	.837	.892	.940	.961	.972	.976	.980	1.920	1.933	g.
12	5.2	6.6	1.411	.572	.717	.800	.858	.900	.952	.970	.980	.982	.988	1.938	1.938	g.+
15	5.6	8.2	1.384	.578	.687	.793	.862	.904	.952	.968	.979	.982	.982	1.925	1.926	g.
17	5.1	10.0	1.352	.552	.683	.776	.838	.888	.943	.960	.978	.981	.985	1.936	1.940	g.−
22	5.2	12.7	1.332	.550	.685	.772	.839	.891	.940	.957	.973	.974	.973	1.944	1.953	g.
27	4.5	7.4	1.381	.573	.700	.789	.852	.904	.949	.966	.979	.980	.984	1.921	1.921	g.+
June 12	3.6	6.2	1.317	.531	.638	.732	.797	.862	.919	.943	.967	.975	.975	1.954	1.952	g.
14	4.0	5.5	1.401	.550	.691	.793	.848	.897	.945	.964	.979	.978	.984	1.932	1.929	g.
25	5.1	6.4	1.423	.587	.713	.806	.863	.905	.956	.970	.981	.983	.988	1.936	1.934	g.
26	4.1	4.8	1.437	.582	.705	.795	.856	.898	.952	.964	.977	.978	.980	1.961	1.957	g.
28	3.6	3.2	1.396	.543	.683	.768	.833	.884	.941	.958	.977	.983	.988	1.934	1.928	g.
July 2	4.9	6.0	1.413	.566	.717	.806	.870	.909	.949	.966	.979	.980	.982	1.930	1.928	g.−
8	4.0	4.2	1.392	.548	.680	.777	.839	.894	.944	.958	.973	.977	.984	1.931	1.926	g.
9	3.7	3.4	1.435	.571	.706	.798	.856	.904	.956	.971	.977	.981	.983	1.940	1.934	g.
10	3.0	1.7	1.467	.592	.710	.795	.861	.899	.949	.968	.980	.982	.983	1.949	1.941	g.
11	3.7	2.0	1.453	.567	.707	.802	.857	.903	.952	.967	.982	.981	.986	1.936	1.928	g.+
28	4.1	7.8	1.317	.527	.663	.756	.823	.882	.936	.954	.975	.978	.979	1.910	1.911	g.−
30	5.1	5.0	1.395	.545	.696	.787	.850	.894	.947	.963	.978	.981	.984	1.929	1.925	g.
Aug. 26	5.1	2.9	1.443	.581	.702	.793	.857	.907	.952	.970	.985	.986	.987	1.922	1.916	g.
Oct. 10	4.2	5.8	1.412	.553	.698	.777	.848	.894	.951	.966	.977	.980	.988	1.948	1.946	g.−
26	6.2	13.9	1.336	.586	.699	.793	.847	.893	.946	.956	.971	.974	.980	1.965	1.975	g.−
28	5.5	12.6	1.314	.582	.694	.792	.866	.890	.944	.960	.969	.976	.979	1.874	1.883	g.−
Nov. 11	4.4	12.7	1.360	.573	.699	.797	.842	.887	.939	.950	.958	.961	.969	1.980	1.989	g.
20	7.1	16.0	1.314	.586	.695	.790	.849	.890	.941	.955	.968	.968	.980	1.925	1.938	g.+
21	5.2	11.2	1.341	.548	.692	.783	.844	.892	.944	.955	.965	.968	.974	1.940	1.946	g.
Dec. 4	4.9	9.9	1.359	.592	.706	.795	.856	.890	.944	.961	.967	.973	.980	1.933	1.937	g.+
6	4.8	11.0	1.279	.569	.696	.784	.830	.874	.925	.937	.948	.950	.956	1.887	1.893	g.+
7	4.8	12.1	1.326	.567	.693	.782	.843	.883	.931	.945	.956	.952	.958	1.950	1.957	g.
20	4.6	9.0	1.387	.604	.723	.820	.867	.907	.954	.967	.978	.979	.981	1.896	1.899	g.+

TABLE 30.—*Solar-constant values. Long method. Mount Brukkaros, 1926–1930*—Continued

Date	Pressure water vapor	Precipitable water	Pyrheliometry mean solar distance, air mass 2.0	Atmospheric transmission for different wave lengths										Solar constant E_0	Solar constant corrected for constant water vapor E'_0	Grade
				Place and wave length												
				46 0.348 μ	38 0.391 μ	32 0.446 μ	28 0.497 μ	22 0.615 μ	19 0.705 μ	17 0.789 μ	14 0.958 μ	11 1.189 μ	6 1.603 μ			
1930	*Mm*	*Mm*														
Jan. 18	3.7	10.7	1.353	0.593	0.701	0.801	0.862	0.908	0.959	0.970	0.980	0.980	0.990	1.895	1.901	v.g.−
Feb. 3	2.7	6.9	1.414	.570	.693	.809	.851	.907	.956	.972	.978	.978	.982	1.948	1.948	v.g.
4	3.0	8.2	1.386	.577	.702	.793	.854	.893	.946	.960	.970	.972	.978	1.928	1.929	v.g.
14	3.9	8.2	1.402	.572	.708	.793	.859	.900	.960	.978	.980	.983	.985	1.924	1.925	g.+
Mar. 11	6.1	12.0	1.360	.580	.709	.801	.857	.901	.955	.970	.978	.975	.984	1.918	1.925	v.g.−
12	3.6	5.1	1.423	.598	.702	.800	.865	.904	.954	.973	.979	.978	.984	1.934	1.938	g.+
24	4.8	1.7	1.351	.603	.714	.801	.867	.903	.959	.970	.984	.985	.986	1.890	1.882	g.+
27	5.5	9.5	1.406	.605	.728	.806	.848	.891	.952	.974	.983	.982	.986	1.951	1.954	g.−
28	4.9	11.4	1.377	.589	.696	.800	.855	.892	.964	.973	.984	.984	.983	1.949	1.955	v.g.−
29	4.0	9.9	1.395	.563	.700	.803	.869	.914	.960	.976	.975	.976	.980	1.962	1.966	g.
Apr. 7	5.0	8.2	1.407	.584	.704	.813	.859	.902	.959	.980	.982	.985	.987	1.946	1.947	v.g.−
9	6.1	6.7	1.405	.588	.690	.814	.864	.908	.954	.965	.974	.974	.986	1.941	1.941	v.g.
10	4.8	6.9	1.404	.584	.692	.792	.864	.896	.952	.967	.976	.976	.986	1.938	1.938	v.g.−
11	4.9	11.8	1.369	.588	.703	.782	.865	.896	.948	.960	.976	.970	.980	1.965	1.972	g.+
May 23	4.1	9.4	1.400	.574	.666	.783	.854	.908	.955	.972	.980	.984	.988	1.962	1.965	v.g.
June 7	5.4	6.8	1.419	.606	.705	.776	.864	.892	.962	.980	.985	.982	.982	1.972	1.972	g.+
9	3.8	6.6	1.398	.585	.701	.800	.857	.907	.960	.976	.990	.989	.990	1.897	1.897	v.g.
10	3.4	6.0	1.408	.546	.679	.772	.840	.896	.952	.963	.977	.983	.986	1.962	1.964	v.g.
13	4.7	3.4	1.458	.598	.710	.804	.869	.903	.960	.973	.977	.977	.980	1.962	1.956	v.g.−
18	2.6	3.2	1.443	.561	.665	.771	.832	.886	.954	.970	.982	.980	.983	1.982	1.975	g.+
20	2.1	3.8	1.417	.527	.694	.773	.856	.906	.946	.964	.976	.979	.982	1.949	1.944	v.g.−
July 3	3.2	4.2	1.423	.571	.694	.796	.861	.908	.961	.973	.987	.987	.981	1.929	1.924	v.g.−
4	3.6	6.3	1.416	.610	.716	.785	.849	.893	.956	.972	.980	.985	.982	1.957	1.955	g.+
28	3.6	4.1	1.423	.578	.688	.789	.859	.900	.953	.968	.982	.984	.985	1.936	1.931	v.g.−
Aug. 5	3.9	4.7	1.386	.596	.696	.768	.845	.891	.946	.960	.977	.980	.980	1.914	1.910	v.g.
6	2.5	3.4	1.401	.549	.673	.781	.824	.884	.949	.969	.985	.984	.982	1.981	1.975	g.
25	5.0	8.3	1.369	.573	.703	.793	.855	.902	.952	.967	.980	.977	.984	1.967	1.968	v.g.
28	1.7	4.1	1.428	.590	.710	.808	.864	.903	.960	.975	.979	.983	.981	1.919	1.914	v.g.
29	1.7	3.7	1.427	.556	.694	.795	.861	.897	.956	.972	.984	.983	.980	1.939	1.934	v.g.
31	2.6	2.8	1.434	.577	.786	.794	.856	.899	.955	.970	.980	.982	.984	1.930	1.924	v.g.
Sept. 11	5.0	11.2	1.314	.587	.691	.788	.847	.895	.952	.965	.980	.980	.985	1.881	1.887	v.g.−
12	4.8	9.8	1.335	.572	.683	.770	.837	.883	.940	.954	.966	.975	.979	1.940	1.944	v.g.−
23	3.3	4.2	1.396	.575	.689	.758	.835	.887	.942	.953	.970	.973	.974	1.964	1.959	v.g.−
24	3.0	3.9	1.332	.562	.678	.761	.834	.885	.938	.951	.968	.975	.982	1.873	1.868	v.g.
29	5.4	13.2	1.310	.580	.697	.799	.856	.895	.950	.963	.971	.971	.972	1.949	1.959	v.g.−
Oct. 13	5.1	7.5	1.382	.591	.707	.799	.855	.900	.953	.966	.975	.976	.982	1.936	1.936	v.g.
31	2.4	6.2	1.397	.602	.708	.806	.862	.906	.958	.968	.980	.978	.980	1.924	1.922	v.g.−
Nov. 1	4.1	10.1	1.363	.598	.706	.799	.856	.896	.948	.960	.973	.974	.975	1.948	1.952	v.g.
3	3.4	7.7	1.372	.583	.706	.796	.858	.902	.951	.961	.975	.980	.974	1.929	1.930	v.g.
4	3.9	9.3	1.355	.583	.696	.803	.857	.900	.953	.965	.978	.980	.976	1.910	1.913	v.g.
5	3.8	9.6	1.344	.596	.712	.793	.855	.897	.942	.955	.967	.968	.961	1.914	1.918	v.g.
Dec. 6	3.1	5.5	1.392	.591	.714	.803	.863	.902	.954	.966	.980	.975	.975	1.911	1.907	v.g.
8	4.0	11.1	1.306	.572	.685	.771	.830	.871	.921	.946	.953	.950	.941	1.984	1.990	v.g.−

SHORT-METHOD RESULTS

We give now the very numerous solar-constant values determined by the short methods at the several stations. As the transmission coefficients of the atmosphere are not individually determined in our computations by this method, they have been omitted in the tables. Moreover, since extensive samples of the prevailing humidity and of the pyrheliometric observations at the several stations have been given in preceding tables (Tables 28, 29*a*, 29*b*, 30), we have omitted these data also to save expense in the following very long series of solar-constant values. Column 1 gives the date; column 2, the number of values secured; column 3, the solar constant and its grade.

As explained in Chapter II we have found that the results of Mount Harqua Hala station are affected by appreciable error due to stray light entering the pyrheliometers from the sky surrounding the position of the sun. This source of error is variable, increasing as the haziness of the sky increases, but now difficult to determine and allow for in the observations. Accordingly we have thought best to omit from this volume the daily observations made at Mount Harqua Hala. Possibly we may revise these observations and publish them later. Those interested may find them given in a preliminary way in Smithsonian Miscellaneous Collections, volume 77, number 3, 1925, covering the period 1920 to 1924, inclusive. We have, however, given in Table 29*a* those of the Harqua Hala long-method values which seemed but slightly affected by the source of error mentioned. They are reduced in scale to fit the scale adopted for the other stations. We have also given Mount Harqua Hala values consideration in fixing the monthly and 10-day mean values of the solar constant given in Tables 45 and 47.

Of the three stations here reported, the results of Montezuma are so much more accurate than the others as to deserve almost exclusive weight in estimating day-to-day changes. Table Mountain and Mount Brukkaros values indeed at some favorable periods approach much nearer than usual the degree of accuracy reached at Montezuma. In general Table Mountain results are much preferable to those observed at Mount Brukkaros. Yet, as will be shown in Chapter VI, all three stations are in close agreement as to 10-day and monthly mean values of the solar constant of radiation. All three give practically identical testimony as to its longer interval fluctuations. Only Montezuma results, however, are accurate enough to give a fair idea of day-to-day variations. Even these come short of a satisfactory representation of these interesting changes. We have in mind certain improvements of apparatus which we hope may be helpful in this matter in future observations.

In Table 32 we give the daily results of Table Mountain *as computed.* We have discovered, as explained in Chapter VI, that from November 8, 1929, through 1929 and 1930 they should be increased by 0.008 calorie on account of incorrect pointing of the pyrheliometers. *This correction is applied in computing the 10-day and monthly means in Table 32 and in all the work reported in Chapter VI.* Also we have found by statistical comparisons that the Table Mountain results indicate a slight yearly range. To correct this we have applied the following corrections to the 10-day and monthly means in Table 32 and to all of the work reported in Chapter VI:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
+0.003	+0.002	+0.001	0.000	0.000	0.000	0.000	0.000	−0.001	−0.001	−0.001	0.000

Table 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*

Date	Number of values	S. C. and grade
1920		
Aug. 1	------	------
2	------	------
3	3	1.905 s.
4	5	1.935 s.
5	4	1.925 s.
6	1	1.962 s.—
7	4	1.933 s.
8	2	1.922 s.—
9	3	1.937 s.
10	2	1.922 s.—
	8	1.930
11	3	1.925 s.
12	4	1.908 s.
13	4	1.918 s.
14	1	1.921 s.—
15	2	1.920 s.—
16	------	------
17	4	1.932 s.
18	2	1.943 s.—
19	3	1.940 s.
20	4	1.934 s.
	9	1.927
21	4	1.930 s.
22	2	1.945 s.
23	4	1.942 s.
24	2	1.901 s.—
25	------	------
26	2	1.945 s.
27	5	1.929 s.
28	4	1.950 s.
29	4	1.916 s.
30	5	1.921 s.
31	5	1.935 s.
	10	1.932
Monthly mean	27	1.930
Sept. 1	5	1.942 s.
2	5	1.947 s.
3	2	1.952 s.
4	------	------
5	2	1.936 u.+
6	5	1.967 s.
7	5	1.946 s.
8	5	1.967 s.
9	4	1.945 s.
10	5	1.959 s.
	9	1.951
11	2	1.926 s.
12	4	1.943 s.
13	4	1.940 s.
14	5	1.950 s.
15	2	1.961 s.—
16	5	1.950 s.
17	5	1.950 s.
18	4	1.947 s.
19	2	1.932 s.
20	------	------
	9	1.944
21	------	------
22	3	1.937 s.

Date	Number of values	S. C. and grade
1920		
Sept. 23	1	1.961 s.
24	5	1.958 s.
25	4	1.944 s.—
26	3	1.939 s.
27	1	1.914 s.—
28	4	1.956 s.—
29	------	------
30	------	------
	7	1.944
Monthly mean	25	1.947
Oct. 1	4	1.943 s.—
2	4	1.928 s.
3	------	------
4	4	1.952 s.
5	4	1.957 s.
6	4	1.929 s.
7	2	1.917 s.—
8	2	1.942 s.—
9	2	1.959 s.
10	2	1.947 s.—
	9	1.942
11	4	1.956 s.
12	3	1.943 s.—
13	------	------
14	------	------
15	3	1.954 s.
16	5	1.958 s.
17	3	1.944 s.—
18	3	1.942 s.—
19	------	------
20	------	------
	6	1.950
21	4	1.951 s.—
22	2	1.945 s.
23	------	------
24	------	------
25	1	1.954 u.+
26	------	------
27	------	------
28	3	1.942 s.—
29	4	1.954 s.
30	2	1.931 s.—
31	2	1.923 s.
	7	1.943
Monthly mean	22	1.944
Nov. 1	4	1.960 s.
2	2	1.956 s.
3	2	1.956 s.
4	2	1.952 s.—
5	4	1.950 s.
6	3	1.948 s.
7	2	1.945 s.—
8	2	1.950 s.
9	3	1.947 s.
10	3	1.949 s.—
	10	1.951

Date	Number of values	S. C. and grade
1920		
Nov. 11	3	1.955 s.
12	2	1.938 s.—
13	4	1.950 s.
14	2	1.942 s.
15	5	1.953 s.
16	2	1.925 s.—
17	2	1.964 s.—
18	3	1.942 s.
19	------	------
20	------	------
	8	1.946
21	1	1.957 s.—
22	2	1.945 s.—
23	2	1.956 s.
24	2	1.935 s.
25	2	1.949 s.—
26	2	1.938 s.—
27	2	1.938 s.—
28	------	------
29	------	------
30	------	------
	7	1.945
Monthly mean	25	1.948
Dec. 1	------	------
2	------	------
3	2	1.944 s.
4	2	1.966 s.
5	4	1.955 s.
6	3	1.959 s.—
7	3	1.954 s.
8	4	1.959 s.
9	------	------
10	3	1.965 s.—
	7	1.957
11	4	1.977 s.
12	2	1.959 s.
13	3	1.957 s.—
14	3	1.946 s.
15	4	1.949 s.
16	2	1.953 s.
17	2	1.962 s.
18	2	1.954 s.
19	2	1.959 s.—
20	2	1.950 s.
	10	1.957
21	------	------
22	1	1.962 s.—
23	------	------
24	------	------
25	1	1.944 s.—
26	------	------
27	------	------
28	------	------
29	------	------
30	2	1.954 s.
31	2	1.966 s.
	4	1.956
Monthly mean	21	1.957

Date	Number of values	S. C. and grade
1921		
Jan. 1	------	------
2	------	------
3	------	------
4	2	1.968 s.—
5	2	1.964 s.—
6	3	1.931 s.
7	2	1.954 s.
8	2	1.954 s.
9	------	------
10	1	1.968 s.
	6	1.956
11	------	------
12	------	------
13	------	------
14	1	1.964 s.—
15	2	1.962 s.
16	------	------
17	------	------
18	1	1.932 s.—
19	------	------
20	------	------
	3	1.953
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
31	------	------
	------	------
Monthly mean	9	1.955
Feb. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	------	------
11	2	1.956 s.—
12	1	1.947 s.—
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	2	1.952
21	2	1.959 s.—
22	------	------

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1921		
Feb. 23	------	------
24	2	1.946 s.
25	2	1.960 s.
26	2	1.955 s.
27	------	------
28	2	1.972 s.–
	5	1.958
Monthly mean..	7	1.956
Mar. 1	2	1.963 s.–
2	1	1.954 s.–
3	2	1.959 s.–
4	2	1.956 s.–
5	2	1.943 s.–
6	2	1.946 s.–
7	2	1.952 s.
8	------	------
9	------	------
10	1	1.957 s.–
	8	1.954
11	------	------
12	------	------
13	1	1.949 s.–
14	1	1.868 u.
15	------	------
16	------	------
17	2	1.950 s.–
18	2	1.915 s.
19	2	1.948 s.–
20	------	------
	4	1.940
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
31	------	------
	------	------
Monthly mean..	12	1.949
Apr. 1	2	1.948 s.–
2	1	1.957 s.–
3	------	------
4	------	------
5	1	1.965 s.–
6	1	1.953 s.–
7	------	------
8	2	1.950 s.
9	2	1.950 s.–
10	2	1.931 s.–
	7	1.951
11	------	------
12	3	1.922 s.

Date	Number of values	S. C. and grade
1921		
Apr. 13	------	------
14	2	1.956 s.–
15	2	1.947 s.–
16	2	1.946 s.–
17	2	1.952 s.–
18	2	1.945 s.–
19	2	1.920 s.–
20	------	------
	7	1.941
21	1	1.921 s.
22	------	------
23	------	------
24	------	------
25	1	1.946 s.–
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
	2	1.934
Monthly mean..	16	1.944
May 1	------	------
2	------	------
3	2	1.946 s.–
4	2	1.950 s.
5	1	1.933 s.–
6	2	1.950 s.
7	------	------
8	2	1.955 s.
9	2	1.944 s.
10	------	------
	6	1.946
11	------	------
12	------	------
13	------	------
14	2	1.941 s.
15	2	1.937 s.
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	2	1.939
21	2	1.868 u.
22	2	1.937 s.
23	2	1.935 s.
24	------	------
25	2	1.950 s.
26	------	------
27	------	------
28	1	1.941 s.–
29	------	------
30	------	------
31	------	------
	4	1.941
Monthly mean..	12	1.943

Date	Number of values	S. C. and grade
1921		
June 1	------	------
2	------	------
3	------	------
4	2	1.943 s.
5	------	------
6	------	------
7	1	1.914 s.–
8	2	1.938 s
9	5	1.938 s
10	------	------
	4	1.933
11	2	1.929 s.
12	------	------
13	1	1.937 s.–
14	------	------
15	------	------
16	------	------
17	------	------
18	2	1.950 s.
19	2	1.929 s.
20	1	1.933 s.–
	5	1.936
21	1	1.942 s.–
22	2	1.955 s.–
23	------	------
24	2	1.943 s.–
25	2	1.940 s.
26	2	1.941 s.
27	2	1.940 s.–
28	3	1.944 s.
29	2	1.952 s.
30	------	------
	8	1.945
Monthly mean..	17	1.939
July 1	3	1.948 s.–
2	2	1.955 s.
3	2	1.956 s.–
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	2	1.968 s.
10		1.973 s.
	5	1.960
11	3	1.945 s.–
12	------	------
13	2	1.960 s.
14	3	1.963 s.
15	1	2.026 u.
16	------	------
17	------	------
18	------	------
19	------	------
20	2	1.961 s.–
	4	1.957
21	3	1.968 s.
22	3	1.960 s.

Date	Number of values	S. C. and grade
1921		
July 23	------	------
24	------	------
25	2	1.960 s.
26	3	1.934 s.
27	2	1.930 s.–
28	1	1.964 s.–
29	2	1.958 s.
30	------	------
31	1	1.947 s.–
	8	1.953
Monthly mean..	17	1.956
Aug. 1	4	1.944 s.
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	1	1.944
11	------	------
12	------	------
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	------	------
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
31	------	------
	------	------
Monthly mean..	1	1.944
Sept. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	------	------

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1921		
Sept. 11	------	------
12	------	------
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	------	------
21	------	------
22	------	------
23	------	------
24	1	1.953 s.−
25	2	1.981 s.
26	------	------
27	3	1.970 s.
28	3	1.969 s.
29	------	------
30	5	1.971 s.
	5	1.969
Monthly mean	5	1.969
Oct. 1	------	------
2		
3	4	1.946 s.
4	4	1.975 s.
5	4	1.954 s.
6	2	1.976 s.
7	4	1.968 s.
8	3	1.948 s.
9	2	1.945 s.
10	1	2.039 u.
	7	1.959
11	------	------
12	------	------
13	2	1.960 s.−
14	------	------
15	------	------
16	1	1.978 s.−
17	------	------
18	1	2.017 u.
19	------	------
20	------	------
	2	1.969
21	------	------
22	1	1.954 s.
23	3	1.978 s.
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
31	------	------
	2	1.966
Monthly mean	11	1.962

Date	Number of values	S. C. and grade
1921		
Nov. 1	------	------
2	------	------
3	------	------
4	3	1.953 s.
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	1	1.953
11	------	------
12	------	------
13	------	------
14	------	------
15	1	1.908 u.
16	1	1.945 s.
17	4	1.963 s.
18	4	1.941 s.
19	4	1.938 s.
20	3	1.959 s.
	5	1.949
21	4	1.956 s.
22	------	------
23	3	1.933 s.
24	2	1.963 s.−
25	4	1.945 s.
26	4	1.949 s.
27	3	1.957 s.
28	2	1.964 s.
29	2	1.947 s.
30	------	------
	8	1.952
Monthly mean	14	1.951
Dec. 1	2	1.903 s.
2	4	1.945 s.+
3	3	1.947 s.
4	3	1.954 s.
5	3	1.954 s.
6	3	1.946 s.
7	2	1.969 s.
8	2	1.971 s.−
9	4	1.961 s.
10	3	1.948 u.+
	10	1.956
11	3	1.948 s.
12	------	------
13	------	------
14	3	1.927 s.
15	------	------
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	2	1.938
21	------	------
22	------	------
23	------	------

Date	Number of values	S. C. and grade
1921		
Dec. 24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
31	------	------
Monthly mean	12	1.953
1922		
Jan. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	1	1.924 s.−
9	------	------
10	------	------
	1	1.924
11	2	1.933 u.
12	2	1.923 s.−
13	2	1.943 s.−
14	3	1.942 s.−
15	3	1.953 s.
16	2	1.971 s.
17	3	1.950 s.
18	------	------
19	1	1.959 s.−
20	1	1.937 s.
	9	1.946
21	1	1.960 s.
22	1	1.942 s.
23	------	------
24	1	1.958 s.
25	1	1.928 s.
26	1	1.937 s.
27	1	1.945 s.
28	1	1.952 s.
29	------	------
30	1	1.988 s.−
31	1	1.960 s.
	9	1.952
Monthly mean	19	1.948
Feb. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	1	1.911 s.−
	1	1.911

Date	Number of values	S. C. and grade
1922		
Feb. 11	------	------
12	1	1.978 u.
13	1	1.939 s.
14	------	------
15	1	1.968 s.−
16	------	------
17	------	------
18	1	1.997 u.
19	1	1.933 s.−
20	------	------
	3	1.947
21	------	------
22	1	1.959 s.
23	1	1.931 s.
24	1	1.970 s.
25	1	1.937 s.
26	------	------
27	------	------
28	1	1.941 s.
	5	1.948
Monthly mean	9	1.943
Mar. 1	------	------
2	1	1.875 u.
3	1	1.933 s.−
4	1	2.060 u.
5	------	------
6	1	1.881 u.
7	1	1.966 s.−
8	1	1.893 u.
9	------	------
10	1	2.004 u.
	2	1.949
11	1	1.964 s.−
12	1	1.948 s.−
13	1	1.909 s.−
14	------	------
15	------	------
16	------	------
17	1	1.934 s.−
18	------	------
19	------	------
20	------	------
	4	1.939
21	------	------
22	2	1.937 s.
23	3	1.944 s.−
24	3	1.933 s.−
25	3	1.926 s.−
26	------	------
27	1	1.920 s.−
28	------	------
29	------	------
30	------	------
31	------	------
	5	1.932
Monthly mean	11	1.938

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1922		
Apr. 1	------	------
2	------	------
3	------	------
4	------	------
5	3	1.930 s.
6	3	1.918 s.
7	4	1.928 s.−
8	3	1.938 s.
9	2	1.936 s.−
10	------	------
	5	1.930
11	3	1.940 s.
12	3	1.887 u.
13	1	1.996 u.
14	------	------
15	------	------
16	------	------
17	------	------
18	2	1.936 s.
19	2	1.936 s.
20	------	------
	3	1.937
21	------	------
22	2	1.919 s.
23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	1	1.942 s.
30	2	1.913 s.
	3	1.925
Monthly mean..	11	1.931
May 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	1	1.911 s.−
9	3	1.887 u.
10	4	1.937 s.−
	2	1.924
11	3	1.923 s.
12	2	1.933 s.
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	3	1.919 u.+
20	------	------
	3	1.925
21	------	------
22	------	------

Date	Number of values	S. C. and grade
1922		
May 23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
31	------	------
	------	------
Monthly mean..	5	1.925
June 1	2	1.906 s.
2	2	1.905 s.
3	2	1.920 s.
4	------	------
5	------	------
6	------	------
7	3	1.890 u.
8	------	------
9	------	------
10	------	------
	3	1.910
11	------	------
12	------	------
13	------	------
14	1	1.906 s.−
15	2	1.923 s.
16	3	1.932 s.−
17	------	------
18	------	------
19	1	1.891 s.−
20	------	------
	4	1.913
21	------	------
22	------	------
23	------	------
24	------	------
25	2	1.924 s.−
26	------	------
27	------	------
28	------	------
29	2	1.898 s.−
30	3	1.939 s.−
	3	1.920
Monthly mean..	10	1.914
July 1	2	1.914 s.−
2	3	1.894 s.−
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	2	1.904

Date	Number of values	S. C. and grade
1922		
July 11		------
12	3	1.917 s.−
13	2	1.889 s.
14	3	1.914 s.−
15	2	1.930 s.
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	4	1.913
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	2	1.908 s.−
29	3	1.928 s.−
30	------	------
31	------	------
	2	1.918
Monthly mean..	8	1.912
Aug. 1	2	1.909 s.−
2	------	------
3	------	------
4	------	------
5	1	1.916 s.−
6	------	------
7	------	------
8	1	1.932 s.−
9	------	------
10	------	------
	3	1.919
11	2	1.904 s.−
12	4	1.935 s.
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	2	1.908 s.−
20	------	------
	3	1.916
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	1	1.907 s.−
27	2	1.921 s.−
28	1	1.938 s.−
29	------	------
30	3	1.918 s.−
31	------	------
	4	1.921
Monthly mean..	10	1.918

Date	Number of values	S. C. and grade
1922		
Sept. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	------	------
11	------	------
12	------	------
13	------	------
14	------	------
15	1	1.937 u.
16	3	1.928 s.−
17	------	------
18	------	------
19	------	------
20	1	1.935 s.−
	2	1.932
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	3	1.920 s.
28	1	1.977 u.
29	3	1.912 s.
30	------	------
31		
	2	1.916
Monthly mean..	4	1.924
Oct. 1	2	1.925 s.
2	------	------
3	------	------
4	1	1.915 s.−
5	3	1.914 s.
6	3	1.920 s.
7	3	1.944 s.
8	2	1.934 s.
9	------	------
10	3	1.927 s.
	7	1.926
11	3	1.920 s.−
12	2	1.938 s.
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	2	1.929
21	------	------
22	------	------

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1922		
Oct. 23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	-------	-------
29	1	1.988 u.
30	-------	-------
31	-------	-------
	-------	-------
Monthly mean..	9	1.927
Nov. 1	-------	-------
2	-------	-------
3	3	1.920 s.−
4	3	1.946 s.−
5	-------	-------
6	3	1.909 s.−
7	-------	-------
8	-------	-------
9	-------	-------
10	3	1.942 s.
	4	1.929
11	-------	-------
12	-------	-------
13	-------	-------
14	1	1.958 u.+
15	3	1.924 s.−
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	1	1.924 s.−
	3	1.935
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	2	1.916 s.
26	-------	-------
27	-------	-------
28	-------	-------
29	-------	-------
30	2	1.924 s.−
	2	1.920
Monthly mean..	9	1.929
Dec. 1	-------	-------
2	2	1.912 s.−
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	1	1.912
1922		
Dec. 11	1	1.907 s.−
12	1	1.909 s.−
13	-------	-------
14	2	1.927 s.
15	2	1.921 s.
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	4	1.916
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	1	1.912 u.+
26	-------	-------
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
31	-------	-------
	1	1.912
Monthly mean..	6	1.915
1923		
Jan. 1	-------	-------
2	2	1.946 s.−
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	1	1.946
11	-------	-------
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	-------	-------
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
31	-------	-------
	-------	-------
Monthly mean..	1	1.946
1923		
Feb. 1	-------	-------
2	4	1.933 s.
3	2	1.933 s.
4	-------	-------
5	3	1.934 s.
6	-------	-------
7	3	1.937 s.
8	-------	-------
9	-------	-------
10	-------	-------
	4	1.934
11	-------	-------
12	-------	-------
13	4	1.951 s.
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	1	1.951
21	-------	-------
22	4	1.935 s.
23	1	1.927 s.
24	2	1.922 s.
25	1	1.917 s.
26	1	1.923 s.
27	1	1.917 s.
28	-------	-------
	6	1.923
Monthly mean..	11	1.930
Mar. 1	-------	-------
2	-------	-------
3	-------	-------
4	2	1.917 s.−
5	3	1.930 s.
6	4	1.924 s.−
7	4	1.936 s.
8	4	1.929 s.
9	4	1.939 s.
10	4	1.925 s.
	7	1.929
11	3	1.944 s.
12	3	1.938 s.
13	3	1.943 s.
14	2	1.944 s.−
15	4	1.937 s.
16	-------	-------
17	5	1.932 s.
18	2	1.933 s.
19	4	1.927 s.
20	1	1.923 s.−
	9	1.936
21	2	1.930 s.
22	3	1.915 s.−
23	2	1.946 s.
24	2	1.936 s.
25	2	1.930 s.
1923		
Mar. 26	2	1.926 s.
27	2	1.936 s.
28	2	1.928 s.
29	2	1.945 s.
30	5	1.924 s.
31	3	1.920 s.
	11	1.931
Monthly mean..	27	1.932
Apr. 1	2	1.941 s.
2	5	1.941 s.
3	3	1.931 s.
4	5	1.932 s.
5	5	1.944 s.
6	3	1.938 s.
7	5	1.936 s.
8	3	1.912 s.
9	2	1.928 u.
10	5	1.933 s.
	10	1.934
11	5	1.938 s.
12	5	1.927 s.
13	2	1.927 s.
14	5	1.928 s.
15	5	1.926 s.
16	4	1.926 s.
17	2	1.925 s.
18	5	1.925 s.
19	4	1.932 s.
20	-------	-------
	9	1.928
21	-------	-------
22	2	1.930 s.
23	5	1.938 s.
24	3	1.933 s.
25	2	1.938 s.
26	5	1.931 s.
27	5	1.934 s.
28	5	1.942 s.
29	2	1.933 s.
30	2	1.924 s.
	9	1.934
Monthly mean..	28	1.932
May 1	-------	-------
2	5	1.926 s.
3	5	1.939 s.
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	5	1.936 s.
	3	1.934
11	2	1.938 s.
12	4	1.929 s.
13	2	1.936 s.

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TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1923		
May 14	-------	-------
15	2	2.006 u.
16	-------	-------
17	2	1.939 s.
18	-------	-------
19	-------	-------
20	-------	-------
	4	1.935
21	5	1.928 s.
22	-------	-------
23	-------	-------
24	-------	-------
25	-------	-------
26	1	1.913 u.
27	4	1.937 s.
28	2	1.931 s.
29	5	1.928 s.–
30	1	1.947 s.–
31	3	1.950 s.
	6	1.937
Monthly mean..	13	1.936
June 1	1	1.924 s.
2	2	1.912 s.
3	2	1.907 u.
4	2	1.909 s.
5	5	1.920 s.
6	-------	-------
7	2	1.916 s.–
8	4	1.919 s.
9	4	1.923 s.
10	1	1.900 u.
	7	1.918
11	4	1.925 s.
12	2	1.930 s.–
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	2	1.927 s.
18	2	1.932 s.–
19	4	1.936 s.
20	4	1.929 s.
	6	1.934
21	1	1.928 s.
22	4	1.937 s.–
23	4	1.924 s.
24	2	1.923 s.
25	3	1.938 s.
26	4	1.935 s.
27	4	1.939 s.
28	4	1.932 s.
29	4	1.943 s.
30	2	1.934 s.
	10	1.933
Monthly mean..	23	1.928
1923		
July 1	2	1.940 s.
2	2	1.946 s.
3	2	1.939 s.
4	2	1.932 s.
5	2	1.940 s.
6	4	1.942 s.
7	4	1.909 s.–
8	2	1.928 s
9	-------	-------
10	2	1.934 s.–
	9	1.934
11	2	1.936 s.
12	4	1.928 s.
13	4	1.924 s.
14	2	1.926 s.
15	2	1.924 s.
16	-------	-------
17	2	1.937 s.
18	-------	-------
19	-------	-------
20	2	1.918 s.
	7	1.928
21	2	1.938 s.
22	2	1.947 s.
23	2	1.943 s.
24	5	1.940 s.
25	5	1.947 s.
26	2	1.946 s.
27	2	1.943 s.–
28	2	1.940 s.–
29	-------	-------
30	2	1.947 s.–
31	2	1.945 s.
	10	1.944
Monthly mean..	26	1.936
Aug. 1	-------	-------
2	2	1.946 s.–
3	2	1.943 s.–
4	5	1.938 s.
5	2	1.943 s.
6	2	1.944 s.
7	2	1.939 s.
8	2	1.943 s.
9	2	1.942 s.
10	2	1.936 s.
	9	1.942
11	2	1.933 s.–
12	-------	-------
13	5	1.947 s.
14	3	1.939 s.
15	2	1.942 s.
16	2	1.942 s.
17	2	1.940 s.
18	1	1.947 u.+
19	2	1.923 s.
20	5	1.947 s.
	9	1.940
1923		
Aug. 21	2	1.942 s.
22	2	1.934 s.
23	2	1.942 s.
24	2	1.946 s.
25	2	1.938 s.
26	2	1.942 s.
27	5	1.940 s.
28	-------	-------
29	3	1.938 s.–
30	4	1.947 s.
31	4	1.944 s.
	10	1.941
Monthly mean..	28	1.941
Sept. 1	3	1.950 s.
2	3	1.952 s.
3	2	1.937 s.–
4	3	1.947 s.
5	3	1.949 s.
6	3	1.947 s.
7	5	1.943 s.
8	3	1.941 s.
9	2	1.937 s.
10	3	1.945 s.
	10	1.945
11	1	1.948 u.+
12	4	1.950 s.
13	4	1.948 s.
14	4	1.950 s.
15	5	1.948 s.
16	1	1.923 u.
17	4	1.931 s.
18	4	1.943 s.
19	4	1.950 s.
20	5	1.946 s.
	10	1.944
21	5	1.942 s.
22	2	1.958 u.
23	4	1.940 s.
24	4	1.938 s.
25	3	1.938 s.–
26	-------	-------
27	4	1.936 s.–
28	5	1.951 s.
29	4	1.948 s.
30	4	1.946 s.
	8	1.942
Monthly mean..	28	1.944
Oct. 1	4	1.947 s.
2	3	1.944 s.–
3	3	1.934 s.–
4	2	1.946 s.–
5	4	1.943 s.
4	4	1.931 s.
7	3	1.919 s.
8	4	1.951 s.
9	4	1.937 s.–
10	4	1.944 s.
	10	1.940
1923		
Oct. 11	4	1.942 s.
12	5	1.930 s.
13	4	1.945 s.
14	4	1.948 s.
15	4	1.945 u.+
16	-------	-------
17	4	1.944 s.–
18	-------	-------
19	4	1.946 s.
20	5	1.940 s.
	8	1.942
21	4	1.937 s.
22	4	1.940 s.
23	3	1.944 s.
24	4	1.937 s.
25	4	1.939 s.
26	1	1.944 u.
27	-------	-------
28	5	1.938 s.
29	1	1.932 s.–
30	3	1.939 s.–
31	4	1.936 s.
	9	1.938
Monthly mean..	27	1.940
Nov. 1	-------	-------
2	-------	-------
3	-------	-------
4	4	1.938 s.
5	4	1.934 s.
6	4	1.917 u.
7	5	1.934 s.
8	4	1.929 u.+
9	4	1.927 s.–
10	2	1.941 u.+
	6	1.934
11	4	1.930 s.
12	5	1.939 s.
13	4	1.949 s.
14	4	1.947 s.
15	4	1.947 s.
16	3	1.948 s.
17	4	1.939 s.
18	4	1.939 s.
19	4	1.945 s.
20	5	1.955 s.
	10	1.944
21	4	1.941 s.
22	2	1.950 u.
23	3	1.949 s.–
24	4	1.948 s.–
25	2	1.960 u.
26	4	1.956 u.
27	2	1.960 u.
28	3	1.928 u.
29	-------	-------
30	2	1.936 s.–
	4	1.944
Monthly mean..	20	1.941

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1923		
Dec. 1	-------	-------
2	1	1.947 u.+
3	-------	-------
4	-------	-------
5	-------	-------
6	2	1.949 u.+
7	4	1.942 s.
8	-------	-------
9	-------	-------
10	5	1.929 s.−
	4	1.942
11	4	1.954 u.+
12	-------	-------
13	3	1.922 u.
14	4	1.932 s.
15	4	1.950 u.+
16	-------	-------
17	4	1.923 u.+
18	4	1.948 s.
19	-------	-------
20	5	1.943 s.−
	6	1.942
21	-------	-------
22	4	1.912 u.+
23	4	1.913 u.+
24	4	1.921 s.−
25	2	1.901 u.
26	-------	-------
27	4	1.925 s.
28	4	1.934 s.−
29	5	1.922 s.
30	-------	-------
31	4	1.917 s.−
	7	1.921
Monthly mean	17	1.933
1924		
Jan. 1	4	1.932 s.
2	5	1.932 s.
3	4	1.942 s.
4	5	1.943 s.
5	-------	-------
6	-------	-------
7	5	1.936 s.
8	5	1.944 s.
9	-------	-------
10	4	1.932 s.−
	7	1.937
11	-------	-------
12	4	1.923 u.
13	5	1.939 s.−
14	5	1.939 s.
15	4	1.950 s.
16	5	1.938 s.
17	5	1.934 s.
18	5	1.943 s.
19	5	1.949 s.
20	4	1.949 s.
	8	1.943

Date	Number of values	S. C. and grade
1924		
Jan. 21	5	1.940 s.−
22	5	1.955 s.−
23	4	1.939 s.−
24	-------	-------
25	-------	-------
26	4	1.944 s.−
27	5	1.949 s.−
28	4	1.948 s.−
29	5	1.942 s.−
30	5	1.940 s.−
31	4	1.942 u.+
	9	1.944
Monthly mean	24	1.942
Feb. 1	4	1.937 u.+
2	4	1.941 s.−
3	5	1.925 u.
4	4	1.934 s.−
5	3	1.927 u.
6	5	1.930 u.+
7	4	1.935 s.−
8	5	1.941 s.
9	5	1.939 s.
10	4	1.947 s.−
	8	1.938
11	-------	-------
12	3	1.951 s.−
13	-------	-------
14	-------	-------
15	-------	-------
16	4	1.929 u.
17	3	1.930 u.
18	4	1.935 s.−
19	-------	-------
20	-------	-------
	2	1.943
21	-------	-------
22	4	1.922 u.
23	4	1.940 s.
24	3	1.950 u.
25	5	1.946 s.
26	5	1.937 s.−
27	5	1.939 s.
28	4	1.932 s.−
29	5	1.934 s.−
	6	1.938
Monthly mean	16	1.939
Mar. 1	5	1.940 s.
2	5	1.946 s.
3	5	1.947 s.
4	5	1.958 s.
5	5	1.948 s.
6	4	1.940 s.
7	5	1.952 s.
8	2	1.949 s.−
9	5	1.945 s.
10	5	1.948 s.
	10	1.947

Date	Number of values	S. C. and grade
1924		
Mar. 11	5	1.938 s.−
12	2	1.946 s.−
13	4	1.950 s.−
14	4	1.941 s.−
15	-------	-------
16	4	1.928 u.
17	4	1.920 u.
18	5	1.939 s.−
19	5	1.958 s.
20	4	1.934 s.
	7	1.944
21	4	1.945 s.
22	5	1.948 s.
23	4	1.936 s.−
24	4	1.947 s.
25	-------	-------
26	5	1.941 s.
27	-------	-------
28	3	1.918 u.
29	5	1.923 u.
30	5	1.947 s.
31	4	1.933 s.
	7	1.942
Monthly mean	24	1.945
Apr. 1	5	1.942 s.
2	5	1.937 s.−
3	-------	-------
4	3	1.944 u.
5	-------	-------
6	5	1.940 s.
7	-------	-------
8	-------	-------
9	4	1.937 s.−
10	4	1.953 s.−
	5	1.942
11	5	1.946 s.
12	3	1.938 s.−
13	5	1.952 s.
14	4	1.940 s.−
15	5	1.938 s.
16	4	1.931 u.
17	5	1.950 s.
18	4	1.950 s.−
19	-------	-------
20	2	1.912 u.
	7	1.948
21	5	1.949 s.
22	5	1.944 s.
23	5	1.953 s.
24	5	1.946 s.
25	4	1.943 s.−
26	5	1.950 s.
27	5	1.951 s.
28	4	1.942 s.−
29	3	1.942 s.
30	5	1.928 u.
	9	1.947
Monthly mean	21	1.946

Date	Number of values	S. C. and grade
1924		
May 1	5	1.945 s.
2	5	1.944 s.
3	5	1.949 s.
4	5	1.944 s.
5	4	1.943 s.
6	5	1.947 s.
7	5	1.940 s.
8	5	1.939 s.
9	5	1.947 s.
10	5	1.924 u.
	9	1.944
11	5	1.946 s.−
12	5	1.945 s.−
13	5	1.942 s.
14	1	1.945 u.
15	4	1.944 s.
16	5	1.955 s.
17	3	1.955 u.
18	2	1.943 u.
19	4	1.954 s.
20	5	1.951 s.
	7	1.948
21	5	1.948 s
22	4	1.948 s.
23	-------	-------
24	5	1.951 s.−
25	5	1.947 s.
26	5	1.953 s.
27	5	1.950 s.
28	5	1.950 s.
29	5	1.950 s.
30	4	1.954 s.
31	5	1.949 s.
	10	1.950
Monthly mean	26	1.948
June 1	4	1.950 s.
2	5	1.954 s.
3	4	1.965 s.
4	3	1.953 s.−
5	-------	-------
6	3	1.957 s.−
7	3	1.955 u.
8	-------	-------
9	4	1.955 s.
10	4	1.966 s.−
	7	1.957
11	2	1.953 u.
12	4	1.957 s.−
13	5	1.949 s.
14	-------	-------
15	-------	-------
16	5	1.955 s.−
17	5	1.964 s.−
18	2	1.960 s.−
19	4	1.954 s.−
20	-------	-------
	6	1.956
21	-------	-------
22	4	1.953 s.

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1924		
June 23	5	1.952 s.
24	4	1.958 s.—
25	-------	-------
26	4	1.949 s.
27	3	1.962 u.
28	5	1.956 s.
29	4	1.949 s.
30	5	1.955 s.
	7	1.953
Monthly mean	20	1.956
July 1	5	1.953 s.
2	4	1.949 s.
3	3	1.952 u.
4	-------	-------
5	4	1.946 s.—
6	5	1.939 s.
7	5	1.944 s.
8	5	1.947 s.
9	5	1.943 s.
10	5	1.945 s.
	8	1.946
11	5	1.945 s.
12	5	1.940 s.—
13	4	1.958 s.—
14	4	1.954 s.
15	5	1.968 s.
16	5	1.953 s.
17	4	1.943 s.
18	4	1.945 s.
19	5	1.952 s.
20	4	1.948 s.
	10	1.951
21	4	1.946 s.
22	4	1.957 s.
23	5	1.936 s.
24	5	1.934 s.
25	5	1.930 s.—
26	4	1.950 s.—
27	5	1.949 s.
28	4	1.949 s.
29	-------	-------
30	-------	-------
31	4	1.932 s.
	9	1.942
Monthly mean	27	1.946
Aug. 1	5	1.898 u.
2	2	1.935 u.
3	5	1.956 s.
4	5	1.959 s.—
5	5	1.955 s.—
6	1	1.934 u.
7	-------	-------
8	-------	-------
9	5	1.944 s.
10	5	1.935 s.
	5	1.950

Date	Number of values	S. C. and grade
1924		
Aug. 11	4	1.931 u.
12	-------	-------
13	4	1.940 s.—
14	5	1.931 s.
15	4	1.945 s.—
16	5	1.954 s.
17	5	1.942 s.
18	5	1.940 s.
19	4	1.930 s.
20	5	1.865 u.
	7	1.940
21	-------	-------
22	-------	-------
23	4	1.899 u.
24	4	1.926 s.—
25	5	1.934 s.
26	5	1.936 s.
27	4	1.931 s.
28	5	1.936 s.
29	-------	-------
30	5	1.935 u.+
31	3	1.933 s.—
	7	1.933
Monthly mean	19	1.940
Sept. 1	3	1.927 s.—
2	5	1.939 s.—
3	4	1.938 s.—
4	4	1.908 u.
5	5	1.945 u.
6	5	1.947 s.—
7	5	1.944 s.
8	3	1.949 s.—
9	2	1.938 u.
10	-------	-------
	6	1.941
11	3	1.963 s.—
12	5	1.940 s.
13	5	1.953 s.
14	5	1.951 s.
15	4	1.949 s.
16	-------	-------
17	5	1.942 s.
18	-------	-------
19	3	1.953 s.—
20	5	1.952 s.
	8	1.950
21	5	1.951 s.
22	5	1.945 s.—
23	5	1.929 s.—
24	4	1.915 u.
25	4	1.922 u.
26	5	1.952 s.
27	5	1.964 s.
28	5	1.945 s.
29	-------	-------
30	5	1.962 s.
	8	1.946
Monthly mean	22	1.946

Date	Number of values	S. C. and grade
1924		
Oct. 1	-------	-------
2	-------	-------
3	-------	-------
4	3	1.944 s.—
5	4	1.964 s.—
6	5	1.959 s.
7	4	1.960 u.
8	5	1.946 s.—
9	5	1.946 s.
10	5	1.957 u.
	6	1.953
11	5	1.949 s.—
12	5	1.951 s.
13	4	1.952 s.—
14	3	1.946 s.—
15	5	1.949 s.
16	1	1.959 u.
17	5	1.949 s.
18	5	1.947 s.
19	5	1.951 s.
20	4	1.944 s.
	9	1.949
21	5	1.955 s.—
22	5	1.953 s.—
23	5	1.958 s.
24	5	1.945 s.
25	5	1.936 s.
26	5	1.951 s.
27	3	1.950 s.—
28	5	1.943 s.
29	5	1.950 s.
30	5	1.941 s.
31	5	1.947 s.
	11	1.948
Monthly mean	26	1.949
Nov. 1	5	1.921 s.—
2	5	1.942 s.—
3	4	1.946 s.—
4	5	1.947 s.
5	5	1.960 s.
6	5	1.943 s.
7	5	1.950 s.
8	4	1.954 s.
9	5	1.950 s.
10	5	1.962 s.
	10	1.948
11	5	1.954 s.
12	4	1.946 s.
13	5	1.951 s.—
14	4	1.946 s.
15	5	1.957 s.
16	4	1.955 s.—
17	-------	-------
18	4	1.945 s.—
19	4	1.949 s.
20	5	1.955 s.
	9	1.951

Date	Number of values	S. C. and grade
1924		
Nov. 21	3	1.951 s.—
22	4	1.942 s.
23	3	1.921 u.
24	4	1.947 s.—
25		
26	-------	-------
27	5	1.939 s.
28	4	1.949 s.—
29	5	1.941 s.
30	5	1.948 s.—
	7	1.945
Monthly mean	26	1.948
Dec. 1	4	1.943 s.—
2	4	1.957 s.—
3	4	1.937 s.—
4	3	1.937 s.—
5	2	1.949 s.—
6	3	1.933 s.
7	-------	-------
8	-------	-------
9	3	1.930 u.
10		1.936 s.—
	7	1.942
11	4	1.945 s.—
12	1	1.972 u.
13	3	1.947 s—.
14	-------	-------
15	5	1.935 s.—
16	-------	-------
17	-------	-------
18	4	1.953 s.—
19	4	1.953 s.—
20	-------	-------
	5	1.947
21	3	1.940 s.—
22	4	1.948 s.
23	2	1.935 s.—
24	4	1.940 s.
25	4	1.945 s.
26	4	1.951 u.
27	4	1.935 u.
28	4	1.931 u.
29	4	1.941 s.—
30	4	1.929 u.
31	4	1.934 u.
	8	1.939
Monthly mean	20	1.942
1925		
Jan 1	5	1.936 s.—
2	4	1.940 u.
3	4	1.939 s.—
4	4	1.928 u.
5	4	1.955 s.—
6	-------	-------
7	3	1.944 u.
8	4	1.952 s.—
9	3	1.945 s.—
10	4	1.942 s.
	6	1.945

Table 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1925		
Jan. 11	4	1.947 s.—
12	3	1.933 u.
13	2	1.932 s.—
14	4	1.942 s.—
15	3	1.940 u.
16	3	1.937 u.
17	-------	-------
18	5	1.945 s.—
19	3	1.927 u.
20	-------	-------
	5	1.939
21	-------	-------
22	4	1.957 u.
23	5	1.953 s?
24	4	1.950 s.—
25	4	1.942 s?
26	4	1.943 s?
27	-------	-------
28	-------	-------
29	4	1.929 u.
30	-------	-------
31	4	1.939 u.
	4	1.947
Monthly mean	15	1.943
Feb. 1	-------	-------
2	1	1.935 u.
3	-------	-------
4	4	1.942 u.
5	5	1.935 u.
6	-------	-------
7	5	1.924 u.
8	-------	-------
9	5	1.940 u.
10	-------	-------
	0	0
11	4	1.945 u.
12	-------	-------
13	-------	-------
14	-------	-------
15	2	1.924 u.
16	5	1.952 s.
17	4	1.950 s.—
18	-------	-------
19	3	1.934 u.
20	-------	-------
	2	1.951
21	-------	-------
22	-------	-------
23	1	1.947 u.
24	-------	-------
25	-------	-------
26	4	1.935 s.—
27	4	1.942 s.—
28	4	1.938 u.
	3	1.398
Monthly Mean	5	1.943
1925		
Mar. 1	-------	-------
2	3	1.939 u.
3	5	1.943 s.—
4	2	1.939 u.
5	-------	-------
6	4	1.938 s.—
7	-------	-------
8	3	1.933 u.
9	4	1.944 s.—
10	4	1.940 u.
	4	1.941
11	4	1.943 s.—
12	4	1.937 s.—
13	4	1.934 u.
14	4	1.940 u.
15	4	1.935 s.—
16	4	1.942 s.—
17	5	1.932 s.—
18	4	1.923 u.
19	-------	-------
20	3	1.928 u.
	8	1.936
21	1	1.949 u.
22	3	1.938 s.—
23	4	1.928 s.—
24	4	1.938 s.
25	4	1.938 s.—
26	4	1.943 s.—
27	4	1.938 s.—
28	4	1.946 u.
29	4	1.948 s.—
30	4	1.946 u.
31	4	1.951 s.—
	10	1.941
Monthly mean	22	1.939
Apr. 1	4	1.957 s.
2	4	1.947 s.—
3	4	1.943 s.
4	4	1.941 s.—
5	4	1.946 s.
6	4	1.944 s.
7	4	1.945 s.
8	4	1.934 s.
9	-------	-------
10	-------	-------
	8	1.945
11	2	1.919 u.
12	5	1.955 u.
13	3	1.948 s.—
14	4	1.954 s.
15	4	1.937 s.
16	4	1.948 s.
17	4	1.950 s.
18	3	1.950 s.—
19	4	1.951 s.—
20	5	1.959 s.—
	8	1.950
21	4	1.954 s.
22	4	1.946 s.
1925		
Apr. 23	4	1.951 s.
24	-------	-------
25	-------	-------
26	2	1.940 u.
27	5	1.942 u.
28	5	1.930 u.
29	5	1.936 s.—
30	4	1.942 s.
	5	1.946
Monthly mean	21	1.947
May 1	4	1.943 s.
2	4	1.940 s.
3	4	1.939 s.
4	4	1.939 s.
5	4	1.943 s.
6	5	1.951 s.
7	1	1.943 u.
8	4	1.956 s.
9	4	1.957 s.
10	4	1.950 s.
	9	1.946
11	5	1.952 s.
12	4	1.953 s.
13	4	1.941 s.
14	4	1.952 s.
15	4	1.945 s.
16	4	1.944 s.
17	4	1.961 s.
18	-------	-------
19	5	1.954 s.
20	4	1.948 s.
	9	1.950
21	5	1.961 s.
22	4	1.955 s.
23	5	1.954 s.
24	5	1.952 s.—
25	5	1.946 s.
26	3	1.974 s.—
27	-------	-------
28	-------	-------
29	5	1.946 s.
30	5	1.956 s.
31	4	1.944 s.
	9	1.954
Monthly mean	27	1.950
June 1	3	1.943 s.
2	4	1.948 s.
3	4	1.943 s.
4	3	1.943 s.
5	2	1.937 u
6	-------	-------
7	5	1.938 s.
8	-------	-------
9	-------	-------
10	-------	-------
	5	1.943
1925		
June 11	5	1.953 s.
12	-------	-------
13	5	1.949 s.
14	5	1.947 s.
15	5	1.948 s.
16	4	1.937 s.
17	4	1.934 s.
18	4	1.941 s.
19	4	1.935 s.—
20	-------	-------
	8	1.943
21	4	1.947 s.
22	4	1.947 s.
23	4	1.953 s.
24	4	1.947 s.
25	4	1.953 s.
26	4	1.958 s.
27	4	1.953 s.
28	5	5.943 s.
29	4	1.944 s.
30	5	1.938 s.
	10	1.948
Monthly mean	23	1.945
July 1	4	1.949 s.—
2	5	1.953 s.
3	4	1.951 s.
4	3	1.956 u.
5	2	1.946 s.—
6	1	1.965 u.
7	3	1.961 u.
8	5	1.962 s.
9	1	1.971 u.
10	-------	-------
	5	1.952
11	5	1.960 s.
12	5	1.961 s.
13	4	1.956 s.
14	4	1.947 s.—
15	5	1.955 s.
16	4	1.957 s.
17	5	1.947 s.—
18	-------	-------
19	5	1.949 s.—
20	4	1.951 s.
	9	1.954
21	4	1.953 s.
22	5	1.947 s.
23	5	1.934 s.
24	4	1.950 s.
25	5	1.955 s.
26	4	1.938 u.
27	5	1.937 s.
28	5	1.941 u.
29	5	1.953 s.
30	4	1.945 s.
31	4	1.946 s.
	9	1.947
Monthly mean	23	1.951

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1925		
Aug. 1	5	1.945 s.–
2	5	1.949 s.
3	5	1.943 s.
4	5	1.949 s.
5	4	1.947 s.
6	5	1.956 s.
7	4	1.953 s.
8	5	1.943 s.
9	5	1.951 s.
10	5	1.954 s.
	10	1.949
11	5	1.948 s.
12	5	1.936 s.
13	5	1.941 s.
14	5	1.941 s.–
15	5	1.942 s.–
16	-------	-------
17	-------	-------
18	5	1.940 s.
19	-------	-------
20	-------	-------
	6	1.941
21	5	1.948 s.
22	5	1.948 s.
23	5	1.942 s.
24	5	1.923 s.–
25	5	1.931 u.
26	5	1.931 s.–
27	5	1.944 s.
28	-------	-------
29	-------	-------
30	5	1.941 s.
31	5	1.959 s.
	8	1.942
Monthly mean	24	1.945
Sept. 1	-------	-------
2	-------	-------
3	4	1.951 s.
4	5	1.957 s.
5	5	1.970 s.
6	5	1.957 s.
7	4	1.958 s.
8	4	1.952 s.–
9	5	1.960 s.
10	5	1.946 s.–
	8	1.956
11	5	1.953 s.–
12	5	1.937 s.
13	5	1.943 s.
14	5	1.925 s.–
15	4	1.946 s.
16	5	1.938 s.–
17	4	1.952 s.
18	5	1.959 s.
19	5	1.956 s.
20	5	1.949 s.
	10	1.946
21	1	1.925 u.
22	3	1.941 u.

Date	Number of values	S. C. and grade
1925		
Sept. 23	5	1.954 s.
24	4	1.945 s.
25	5	1.954 s.
26	5	1.949 s.
27	5	1.944 s.
28	5	1.950 s.
29	5	1.947 s.
30	4	1.955 s.
	8	1.950
Monthly mean	26	1.950
Oct. 1	5	1.939 s.
2	5	1.946 s.
3	3	1.931 u.
4	4	1.939 s.–
5	4	1.939 s.–
6	5	1.930 u.
7	5	1.942 s.
8	4	1.944 s.
9	5	1.934 u.
10	5	1.949 s.–
	7	1.942
11	-------	-------
12	5	1.948 s.
13	4	1.954 s.
14	5	1.952 s.
15	5	1.947 u.
16	4	1.955 s.
17	5	1.948 s.–
18	4	1.938 s.–
19	-------	-------
20	-------	-------
	6	1.949
21	-------	-------
22	4	1.943 u.
23	5	1.945 s.
24	5	1.945 s.
25	5	1.946 s.
26	5	1.945 s.
27	5	1.945 s.
28	-------	-------
29	5	1.942 s.
30	4	1.953 s.
31	5	1.945 s.
	8	1.946
Monthly mean	21	1.946
Nov. 1	5	1.937 s.
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	5	1.942 s.
7	5	1.948 s.
8	5	1.949 s.
9	5	1.944 s.
10	4	1.943 s.–
	6	1.944

Date	Number of values	S. C. and grade
1925		
Nov. 11	5	1.942 s.
12	5	1.950 s.
13	5	1.947 s.
14	5	1.950 s.–
15	5	1.940 s.–
16	5	1.946 s.–
17	5	1.945 s.
18	5	1.950 s.–
19	4	1.957 s.–
20	5	1.953 s.
	10	1.948
21	5	1.947 s.
22	5	1.944 s.
23	5	1.947 s.
24	-------	-------
25	5	1.944 s.–
26	-------	-------
27	5	1.941 s.–
28	5	1.943 s.–
29	-------	-------
30	5	1.941 s.
	7	1.944
Monthly mean	23	1.946
Dec. 1	5	1.940 u.
2	5	1.950 u.
3	5	1.943 s.
4	4	1.951 s.
5	5	1.947 s.
6	5	1.944 s.
7	5	1.943 s.
8	5	1.941 s.–
9	5	1.941 s.–
10	5	1.943 s.–
	8	1.944
11	4	1.945 s.–
12	2	1.946 u.
13	-------	-------
14	-------	-------
15	2	1.946 u.
16	-------	-------
17	3	1.939 u.
18	5	1.940 s.–
19	-------	-------
20	4	1.950 s.–
	3	1.945
21	5	1.953 s.
22	5	1.958 s.
23	5	1.942 s.
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	5	1.939 s.–
29	4	1.951 s.
30	5	1.937 s.
31	5	1.945 s.
	7	1.946
Monthly mean	18	1.945

Date	Number of values	S. C. and grade
1926		
Jan. 1	5	1.944 s.–
2	5	1.939 s.–
3	5	1.927 u.
4	-------	-------
5	2	1.937 u.
6	5	1.948 s.
7	5	1.943 s.–
8	5	1.947 s.–
9	5	1.946 s.–
10	-------	-------
	6	1.944
11	4	1.944 s.–
12	5	1.939 s.
13	5	1.950 u.+
14	5	1.942 u.+
15	5	1.946 s.–
16	-------	-------
17	-------	-------
18	5	1.944 s.–
19	-------	-------
20	5	1.934 u.+
	7	1.943
21	4	1.929 u.+
22	-------	-------
23	5	1.932 u.+
24	4	1.936 u.+
25	5	1.934 s.–
26	-------	-------
27	4	1,912 u.
28	-------	-------
29	-------	-------
30	-------	-------
31	-------	-------
	4	1.933
Monthly mean	17	1,941
Feb. 1	2	1.944 u.+
2	5	1.938 s.–
3	-------	-------
4	-------	-------
5	-------	-------
6	3	1.930 u.+
7	4	1.934 u.+
8	5	1.940 s.–
9	-------	-------
10	5	1.944 s.–
	6	1.938
11	3	1.951 u.
12	2	1.908 u.
13	1	1,951 u.
14	-------	-------
15	4	1.949 s.
16	5	1.925 s.–
17	-------	-------
18	5	1.940 s.
19	5	1.944 s.
20	5	1.937 s.
	5	1.939
21	2	1.935 u.
22	-------	-------

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1926		
Feb. 23	------	------
24	------	------
25	5	1.929 s.–
26	------	------
27	------	------
28	------	------
	1	1.929
Monthly mean	12	1.938
Mar. 1	5	1.929 s.–
2	------	------
3	5	1.944 s.
4	5	1.936 u.+
5	5	1.944 s.–
6	5	1.944 s.–
7	5	1.943 s.–
8	------	------
9	------	------
10	5	1.944 s.
	7	1.941
11	5	1.957 s.
12	4	1.959 s.–
13	4	1.944 u.+
14	------	------
15	------	------
16	5	1.945 u.+
17	5	1.926 u.
18	------	------
19	------	------
20	5	1.937 s.–
	5	1.948
21	5	1.929 s.–
22	------	------
23	------	------
24	5	1.939 s.–
25	------	------
26	5	1.933 s.–
27	5	1.932 s.
28	4	1.935 s.
29	4	1.928 s.
30	5	1.938 s.
31	5	1.923 s.–
	8	1.932
Monthly mean	20	1.939
Apr. 1	5	1.935 s.
2	5	1.922 s.
3	5	1.909 s.
4	4	1.907 s.–
5	4	1.927 s.
6	5	1.941 s.
7	5	1.938 s.
8	4	1.931 s.
9	5	1.922 s.
10	5	1.940 s.
	10	1.927
11	4	1.943 s.
12	5	1.939 s.

Date	Number of values	S. C. and grade
1926		
Apr. 13	5	1.945 s.
14	5	1.938 s.
15	4	1.950 s.
16	5	1.938 s.
17	5	1.927 s.
18	5	1.929 s.
19	5	1.931 s.
20	4	1.929 s.
	10	1.937
21	5	1.939 s.
22	5	1.933 s.
23	5	1.935 u.+
24	5	1.932 s.
25	5	1.940 s.
26	5	1.935 s.
27	4	1.936 s.
28	2	1.946 u.
29	5	1.947 s.–
30	4	1.954 s.–
	9	1.939
Monthly mean	29	1.934
May 1	5	1 943 s.
2	5	1.948 s.
3	5	1.938 s.
4	5	1.937 s.
5	5	1.918 s.–
6	4	1.929 s.
7	5	1.941 s.
8	5	1.945 s.
9	5	1.937 s.–
10	2	1.944 u.
	9	1.937
11	4	1.931 u.+
12	5	1.931 s.
13	5	1.945 s.
14	5	1.939 s.–
15	5	1.944 s.
16	------	------
17	------	------
18	5	1.937 s.
19	5	1.941 s.
20	5	1.936 s.
	8	1.938
21	5	1.942 s.
22	5	1.950 s.
23	------	------
24	5	1.936 s.
25	5	1.940 s.
26	5	1.938 s.–
27	4	1.940 s.
28	5	1.946 s.
29	------	------
30	------	------
31	------	------
	7	1.942
Monthly mean	24	1.939

Date	Number of values	S. C. and grade
1926		
June 1	1	1.945 u.+
2	------	------
3	5	1.941 s.
4	3	1.933 u.+
5	------	------
6	5	1.938 s.–
7	------	------
8	5	1.938 s.
9	------	------
10	------	------
	5	1.939
11	5	1.940 s.
12	5	1.937 s.
13	5	1.949 s.
14	5	1.951 s.
15	5	1.951 s.
16	5	1.948 s.
17	5	1.942 s.
18	5	1.948 s.
19	5	1.945 s.
20	3	1.945 u.+
	10	1.946
21	------	------
22	------	------
23	------	------
24	5	1.943 s.–
25	5	1.944 s.
26	5	1.952 s.
27	4	1.941 s.–
28	------	------
29	3	1.919 u.
30	------	------
	4	1.945
Monthly mean	19	1.944
July 1	5	1.940 s.–
2	5	1.938 s.–
3	5	1.935 s.
4	5	1.955 s.
5	4	1.936 s.
6	5	1.939 s.
7	5	1.939 s.
8	5	1.949 s.
9	5	1.945 s.
10	5	1.945 s.
	10	1.942
11	5	1.947 s.
12	5	1.954 s.
13	4	1.946 s.
14	------	------
15	5	1.940 s.
16	2	1.947 s.–
17	5	1.944 s.
18	5	1.949 s.
19	5	1.923 u.
20	5	1.921 u.
	7	1.949
21	5	1.952 s.
22	4	1.939 s.

Date	Number of values	S. C. and grade
1926		
July 23	5	1.949 s.
24	5	1.930 s.
25	4	1.944 s.
26	4	1.945 s.–
27	5	1.946 s.
28	5	1.945 s.
29	5	1.935 s.
30	5	1.945 s.
31	5	1.948 s.
	11	1.944
Monthly mean	28	1.944
Aug. 1	5	1.943 s.
2	5	1.939 s.
3	5	1.946 s.
4	5	1.946 s.
5	5	1.938 s.
6	4	1.946 s.
7	1	1.870 u.
8	------	------
9	2	1.956 u.
10	5	1.958 s.
	7	1.945
11	4	1.949 s.
12	------	------
13	------	------
14	------	------
15	5	1.938 s.
16	5	1.940 s.
17	------	------
18	------	------
19	------	------
20	------	------
	3	1.942
21	------	------
22	------	------
23	------	------
24	3	1.939 u.+
25	5	1.939 s.
26	5	1.946 s.
27	5	1.950 s.
28	5	1.940 s.
29	5	1.946 s.
30	2	1.928 u.
31	4	1.937 s.
	7	1.942
Monthly mean	17	1.944
Sept. 1	4	1.937 s.
2	5	1.944 s.
3	5	1.938 s.
4	5	1.940 s.
5	5	1.947 s.
6	4	1.946 s.
7	5	1.950 s.
8	5	1.940 s.
9	5	1.938 s.
10	------	------
	9	1.942

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1926		
Sept. 11	2	1.931 u.
12	4	1.921 s.
13	5	1.927 u.
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	5	1.945 s–
19	5	1.949 s?
20	5	1.945 s.
	4	1.940
21	5	1.944 s.
22	5	1.939 s.
23	5	1.940 s.
24	5	1.944 s.
25	-------	-------
26	3	1.939 s.–
27	5	1.950 s.
28	5	1.946 s.
29	4	1.942 s.
30	-------	-------
	8	1.943
Monthly mean..	21	1.942
Oct. 1	5	1.931 s.
2	5	1.945 s.
3	5	1.943 s.
4	5	1.909 u.
5	3	1.927 u.
6	-------	-------
7	5	1.928 s.–
8	5	1.926 u.
9	5	1.941 s.
10	5	1.941 s.
	6	1.938
11	5	1.940 s.
12	5	1.943 s.
13	5	1.944 s.
14	5	1.943 s.
15	4	1.935 s.
16	5	1.930 s.
17	5	1.927 s.
18	5	1.936 s.
19	4	1.940 s.
20	5	1.933 s.
	10	1.937
21	5	1.934 s.
22	5	1.936 s.
23	5	1.936 s.
24	2	1.935 u.
25	5	1.919 s.
26	5	1.919 s.–
27	5	1.933 s.
28	5	1.933 s.
29	5	1.927 s.–
30	-------	-------
31	5	1.924 u.+
	9	1.929
Monthly Mean..	25	1.934

Date	Number of values	S. C. and grade
1926		
Nov. 1	5	1.935 s.–
2	4	1.927 s.
3	5	1.938 s.
4	5	1.931 s.
5	5	1.926 s.
6	3	1.940 s.–
7	3	1.929 s.–
8	5	1.924 s.–
9	-------	-------
10	5	1.927 s.
	9	1.931
11	5	1.927 s.–
12	3	1.925 u.+
13	5	1.933 s.–
14	5	1.932 s.–
15	3	1.928 u.
16	5	1.918 u.+
17	5	1.921 u.+
18	-------	-------
19	4	1.926 u.
20	5	1.929 u.+
	7	1.926
21	-------	-------
22	-------	-------
23	-------	-------
24	5	1.929 s.
25	4	1.910 u.
26	-------	-------
27	2	1.928 u.
28	-------	-------
29	1	1.926 u.
30	2	1.931 s.–
	2	1.930
Monthly mean..	18	1.929
Dec. 1	-------	-------
2	-------	-------
3	5	1.924 u.
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	5	1.936 s.
10	5	1.934 s.
	2	1.935
11	5	1.933 s.
12	5	1.937 s.–
13	5	1.933 s.
14	5	1.932 s.–
15	5	1.931 s.–
16	5	1.932 s.
17	-------	-------
18	5	1.921 s.
19	1	1.924 u.
20	5	1.927 s.
	8	1.931
21	-------	-------
22	-------	-------

Date	Number of values	S. C. and grade
1926		
Dec. 23	-------	-------
24	5	1.935 s.
25	4	1.930 u.
26	-------	-------
27	2	1.923 u.
28	3	1.926 u.
29	-------	-------
30	-------	-------
31	-------	-------
	1	1.935
Monthly mean..	11	1.932
1927		
Jan. 1	2	1.933 u.+
2	5	1.935 s.
3	5	1.939 s.
4	4	1.944 s.
5	5	1.933 s.
6	5	1.927 s.
7	5	1.943 s.
8	5	1.947 s.
9	5	1.941 u.+
10	5	1.951 u.+
	10	1.939
11	-------	-------
12	4	1.943 s.–
13	5	1.937 s.–
14	5	1.934 s.–
15	-------	-------
16	-------	-------
17	5	1.923 u.
18	-------	-------
19	-------	-------
20	-------	-------
	3	1.938
21	-------	-------
22	2	1.932 u.+
23	5	1.937 s.
24	-------	-------
25	5	1.923 s.–
26	-------	-------
27	2	1.919 u.
28	-------	-------
29	-------	-------
30	5	1.913 u.
31	-------	-------
	3	1.931
Monthly mean..	16	1.938
Feb. 1	-------	-------
2	-------	-------
3	-------	-------
4	5	1.941 s.–
5	-------	-------
6	3	1.913 u.
7	-------	-------
8	5	1.924 s.–
9	5	1.937 s.
10	5	1.943 s.
	4	1.936

Date	Number of values	S. C. and grade
1927		
Feb. 11	5	1.941 s.
12	4	1.940 s.
13	5	1.944 s.–
14	5	1.948 s.
15	5	1.944 s.
16	5	1.951 s.–
17	3	1.945 u.+
18	-------	-------
19	5	1.953 s.–
20	-------	-------
	8	1.946
21	-------	-------
22	-------	-------
23	-------	-------
24	5	1.919 u.
25	-------	-------
26	-------	-------
27	-------	-------
28	1	1.945 u.
	-------	-------
Monthly mean..	12	1.943
Mar. 1	3	1.928 u.
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	4	1.935 u.
8	1	1.938 u.
9	-------	-------
10	2	1.921 u.
	-------	-------
11	-------	-------
12	-------	-------
13	5	1.945 s.–
14	5	1.948 s.
15	5	1.940 s.
16	-------	-------
17	-------	-------
18	-------	-------
19	5	1.945 s.
20	-------	-------
	4	1.944
21	4	1.951 s.
22	5	1.942 s.
23	5	1.953 s.
24	5	1.946 s.–
25	5	1.945 u.+
26	5	1.953 s.–
27	3	1.943 u.+
28	5	1.942 s.–
29	5	1.917 s.–
30	5	1.922 s.–
31	1	1.959 u.
	10	1.941
Monthly mean..	14	1.942

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1927		
Apr. 1	5	1.932 u.
2	5	1.947 s.
3	4	1.942 s.
4	-------	-------
5	5	1.942 s.
6	-------	-------
7	-------	-------
8	-------	-------
9	4	1.937 s.—
10	4	1.939 s.—
	5	1.941
11	5	1.940 s.
12	5	1.950 s.
13	4	1.950 s.
14	5	1.938 s.
15	5	1.942 s.
16	5	1.952 s.
17	4	1.943 s.—
18	5	1.950 s.
19	5	1.947 s.
20	4	1.944 s.
	10	1.945
21	5	1.952 s.
22	-------	-------
23	5	1.926 s.—
24	-------	-------
25	5	1.944 s.—
26	5	1.947 s.
27	4	1.950 s.
28	5	1.951 s.
29	5	1.947 s.
30	4	1.943 s.
	8	1.945
Monthly mean..	23	1.944
May 1	5	1.944 s.
2	5	1.946 s.
3	4	1.947 s.
4	5	1.950 s.
5	5	1.950 s.
6	-------	-------
7	5	1.945 s.
8	1	1.938 u.
9	5	1.949 s.—
10	4	1.943 s.
	8	1.947
11	-------	-------
12	5	1.940 s.
13	5	1.945 s.
14	5	1.944 s.—
15	-------	-------
16	-------	-------
17	-------	-------
18	2	1.938 u.
19	5	1.951 s?
20	5	1.940 s.
	5	1.944
21	5	1.950 s.
22	5	1.941 s.

Date	Number of values	S. C. and grade
1927		
May 23	5	1.944 s.
24	4	1.940 s.
25	5	1.928 s.
26	5	1.941 s.
27	5	1.949 s.
28	5	1.943 s.
29	5	1.953 s.
30	5	1.947 s.
31	5	1.944 s.
	11	1.944
Monthly mean..	24	1.945
June 1	5	1.949 s.—
2	5	1.953 s.
3	5	1.955 s.—
4	5	1.948 s.
5	5	1.951 s.
6	-------	-------
7	5	1.951 s.
8	4	1.951 s.
9	5	1.949 s.
10	5	1.945 s.
	9	1.950
11	5	1.945 s.
12	5	1.943 s.
13	5	1.942 s.
14	5	1.940 s.
15	5	1.938 s.
16	5	1.947 s.—
17	4	1.947 s.—
18	-------	-------
19	-------	-------
20	-------	-------
	7	1.943
21	-------	-------
22	-------	-------
23	5	1.942 s.
24	4	1.945 s.
25	5	1.951 s.
26	5	1.943 s.
27	5	1.943 s.
28	4	1.946 s.
29	4	1.951 s.—
30	5	1.939 s.
	8	1.945
Monthly mean..	24	1.946
July 1	4	1.951 s.
2	5	1.953 s.
3	-------	-------
4	-------	-------
5	5	1.956 s.—
6	-------	-------
7	3	1.944 u.+
8	5	1.945 s.
9	-------	-------
10	5	1.945 s.
	6	1.949

Date	Number of values	S. C. and grade
1927		
July 11	4	1.941 s.
12	5	1.937 s.
13	4	1.939 s.
14	5	1.939 s.
15	5	1.939 s.
16	5	1.941 s.
17	5	1.948 s.
18	4	1.947 s.
19	5	1.944 s.
20	5	1.949 s.
	10	1.942
21	5	1.949 s.
22	5	1.942 s.
23	5	1.945 s.
24	5	1.948 s.
25	4	1.952 s.
26	2	1.950 s.
27	4	1.947 s.
28	5	1.945 s.
29	5	1.937 s.
30	5	1.945 s.
31	5	1.944 s.
	11	1.946
Monthly mean..	27	1.945
Aug. 1	4	1.940 s.
2	5	1.945 s.
3	5	1.940 s.
4	5	1.940 s.
5	5	1.942 s.
6	5	1.942 s.
7	5	1.946 s.
8	-------	-------
9	5	1.940 s.
10	5	1.941 s.
	9	1.942
11	5	1.934 s.—
12	-------	-------
13	-------	-------
14	5	1.938 s.
15	5	1.947 s.
16	4	1.943 s.
17	5	1.943 s.
18	5	1.947 s.
19	5	1.933 s.
20	5	1.942 s.
	8	1.941
21	5	1.931 s.
22	5	1.934 s.
23	5	1.932 s.
24	5	1.935 s.
25	5	1.936 s.—
26	5	1.938 s.
27	5	1.939 s.
28	5	1.951 s.
29	5	1.950 s.
30	4	1.956 s.
31	5	1.952 s.
	11	1.941
Monthly mean..	28	1.941

Date	Number of values	S. C. and grade
1927		
Sept. 1	5	1.940 u.
2	5	1.941 s.
3	5	1.943 s.
4	5	1.947 s.
5	5	1.948 s.
6	5	1.944 s.—
7	-------	-------
8	-------	-------
9	5	1.935 u.
10	4	1.936 s.—
	6	1.940
11	3	1.939 u.
12	4	1.936 s.
13	5	1.940 s.—
14	4	1.945 s.
15	5	1.946 s.
16	5	1.940 s.
17	5	1.942 s.
18	5	1.940 s.
19	5	1.942 s.
20	4	1.945 s.
	9	1.942
21	5	1.952 s.
22	5	1.953 s.
23	5	1.950 s.
24	5	1.946 s.
25	-------	-------
26	-------	-------
27	-------	-------
28	5	1.930 u.
29	4	1.942 u.
30	5	1.948 s.
	5	1.950
Monthly mean..	20	1.944
Oct. 1	5	1.947 s.
2	-------	-------
3	5	1.946 s.
4	4	1.939 s.
5	5	1.943 s.
6	5	1.946 s.
7	5	1.945 s.
8	-------	-------
9	3	1.940 u.
10	5	1.952 s.
	7	1.945
11	5	1.945 s.
12	4	1.948 s.
13	5	1.946 s.
14	5	1.946 s.—
15	5	1.940 s.—
16	5	1.942 s.—
17	-------	-------
18	-------	-------
19	1	1.937 u.
20	5	1.942 s.—
	7	1.944
21	5	1.952 s.
22	4	1.948 s.
23	3	1.933 u.
24	-------	-------

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1927		
Oct. 25	5	1.945 s.
26	5	1.941 s.
27	5	1.936 s.–
28	1	1.929 u.
29	5	1.942 s.
30	5	1.939 s.–
31	4	1.943 s.–
	8	1.943
Monthly mean	22	1.944
Nov. 1	2	1.944 u.
2	5	1.940 s.
3	4	1.946 s.
4	5	1.940 s.
5	3	1.935 u.
6	------	------
7	5	1.948 s.
8	5	1.944 s.
9	5	1.949 s.
10	4	1.946 s.
	7	1.945
11	5	1.939 s.
12	5	1.942 s.
13	5	1.948 s.
14	------	------
15	5	1.949 s.–
16	------	------
17	3	1.944 u.
18	2	1.944 u.
19	5	1.935 s.–
20	------	------
	5	1.943
21	------	------
22	5	1.951 s.–
23	4	1.942 s.
24	5	1.947 s.
25	5	1.933 s.
26	------	------
27	------	------
28	------	------
29	4	1.941 s.
30	5	1.947 s.
	6	1.944
Monthly mean	18	1.944
Dec. 1	5	1.954 s.
2	4	1.951 s.
3	5	1.945 s.
4	------	------
5	------	------
6	5	1.934 u.
7	5	1.950 s.
8	5	1.947 s.
9	5	1.948 s.–
10	4	1.945 s.
	7	1.949
11	5	1.942 s.
12	5	1.938 u.
13	------	------
1927		
Dec. 14	4	1.944 u.
15	5	1.927 s.–
16	3	1.919 u.
17	------	------
18	2	1.928 u.
19	------	------
20	------	------
	2	1.935
21	------	------
22	5	1.930 s.–
23	------	------
24	1	1.925 u.
25	5	1.942 s.
26	5	1.939 s.
27	5	1.937 s.–
28	5	1.946 s.–
29	5	1.940 s.–
30	5	1.937 s.–
31	------	------
	7	1.939
Monthly Mean	16	1.942
1928		
Jan. 1	------	------
2	2	1.948 u.
3	4	1.935 s.
4	5	1.940 s.–
5	5	1.949 s.
6	5	1.942 s.
7	------	------
8	5	1.947 s.
9	5	1.937 s.–
10	5	1.936 s.–
	7	1.941
11	5	1.930 s.–
12	------	------
13	4	1.930 u.
14	5	1.933 u.
15	4	1.929 u.
16	5	1.932 s.–
17	2	1.919 u.
18	2	1.919 u.
19	------	------
20	------	------
	2	1.931
21	------	------
22	------	------
23	------	------
24	4	1.949 s.–
25	3	1.960 u.
26	------	------
27	4	1.927 s.–
28	5	1.939 s.
29	5	1.942 s.
30	5	1.946 s.
31	5	1.951 s.
	6	1.942
Monthly mean	15	1.940
1928		
Feb. 1	5	1.945 s.
2	5	1.948 s.
3	5	1.942 s.
4	------	------
5	4	1.943 s.–
6	1	1.942 u.
7	4	1.952 s.
8	4	1.946 s.
9	5	1.954 s.
10	3	1.933 u.
	7	1.947
11	5	1.938 s.
12	5	1.945 s.
13	5	1.940 s.
14	5	1.942 s.–
15	------	------
16	5	1.939 s.–
17	5	1.940 s.–
18	5	1.945 s.–
19	------	------
20	------	------
	7	1.941
21	5	1.939 s.–
22	------	------
23	------	------
24	------	------
25	1	1.915 u.
26	------	------
27	3	1.939 u.
28	------	------
29	5	1.928 s.–
	2	1.934
Monthly mean	16	1.943
Mar. 1	------	------
2	5	1.944 s.–
3	2	1.948 u.
4	5	1.956 s.–
5	5	1.940 s.–
6	2	1.945 u.
7	5	1.944 s.
8	5	1.949 s.–
9	4	1.961 s.
10	5	1.946 s.
	7	1.950
11	5	1.941 s.
12	5	1.957 s.
13	------	------
14	------	------
15	5	1.942 s.–
16	2	1.937 u.
17	5	1.922 s.–
18	5	1.944 s.–
19	5	1.956 s.–
20	4	1.956 s.–
	7	1.945
21	5	1.949 s.
22	5	1.944 s.
1928		
Mar. 23	3	1.933 s.–
24	------	------
25	1	1.945 u.
26	5	1.944 s.–
27	5	1.955 s.
28	1	1.955 u.
29	5	1.950 s.–
30	3	1.940 u.
31	5	1.941 s.–
	7	1.945
Monthly mean	21	1.946
Apr. 1	3	1.946 u.
2	3	1.953 s.–
3	5	1.943 s.
4	3	1.924 u.
5	5	1.952 s.
6	5	1.950 s.
7	5	1.945 s.
8	5	1.945 s.
9	4	1.941 s.
10	5	1.938 s.
	8	1.946
11	5	1.939 s.
12	5	1.939 s.
13	5	1.941 s.
14	2	1.932 u.
15	5	1.940 s.–
16	5	1.940 s.–
17	5	1.935 u.
18	------	------
19	5	1.935 s.–
20	5	1.945 s.–
	7	1.940
21	------	------
22	------	------
23	------	------
24	5	1.946 s.–
25	5	1.924 u.
26	5	1.940 s.–
27	5	1.942 s.–
28	4	1.935 s.–
29	5	1.939 s.
30	5	1.939 s.
	6	1.940
Monthly mean	21	1.942
May 1	3	1.940 s.–
2	5	1.933 u.
3	5	1.946 s.
4	5	1.934 s.–
5	5	1.940 s.
6	5	1.947 s.
7	5	1.948 s.
8	5	1.945 s.
9	5	1.942 s.–
10	5	1.945 s.
	9	1.943

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1928		
May 11	4	1.949 s.
12	5	1.946 s.
13	5	1.946 s.
14	5	1.949 s.—
15	-------	-------
16	5	1.950 s.—
17	2	1.944 u.
18	5	1.954 s.—
19	5	1.955 s.—
20	5	1.957 s.
	8	1.951
21	5	1.958 s.
22	4	1.956 s.
23	5	1.949 s.
24	5	1.951 s.
25	4	1.942 u.
26	5	1.944 s.—
27	5	1.943 s.—
28	5	1.947 s.—
29	5	1.944 s.—
30	3	1.946 s.—
31	-------	-------
	9	1.949
Monthly Mean..	26	1.947
June 1	3	1.947 s.—
2	5	1.945 s.—
3	5	1.944 s.
4	5	1.946 s.—
5	5	1.949 s.
6	5	1.949 s.—
7	5	1.955 s.
8	5	1.948 s.
9	4	1.940 s.
10	5	1.945 s.—
	10	1.947
11	5	1.947 s.—
12	5	1.937 s.—
13	5	1.945 s.—
14	-------	-------
15	-------	-------
16	1	1.955 u.
17	5	1.958 s.—
18	-------	-------
19	2	1.954 s.
20	-------	-------
	5	1.948
21	3	1.950 s.—
22	5	1.966 s.—
23	5	1.955 s.—
24	-------	-------
25	3	1.943 u.
26	-------	-------
27	5	1.936 u.
28	5	1.933 s.—
29	1	1.941 u.
30	2	1.940 u.
	4	1.951
Monthly Mean..	19	1.948

Date	Number of values	S. C. and grade
1928		
July 1	5	1.947 s.
2	5	1.948 s.
3	4	1.945 s.
4	5	1.937 s.
5	5	1.935 s.
6	5	1.942 s.
7	5	1.947 s.
8	5	1.943 s.
9	5	1.945 s.
10	5	1.939 s.—
	10	1.943
11	5	1.938 s.—
12	5	1.921 u.
13	-------	-------
14	5	1.936 s.
15	4	1.938 s.
16	5	1.936 s.—
17	5	1.955 s.—
18	5	1.940 s.—
19	5	1.948 s.—
20	5	1.942 s.—
	8	1.942
21	4	1.940 s.
22	1	1.935 u.
23	2	1.942 u.
24	5	1.924 u.
25	4	1.938 s.
26	5	1.942 s.—
27	-------	-------
28	5	1.940 s.
29	5	1.938 s.
30	5	1.941 s.
31	1	1.948 u.
	6	1.940
Monthly Mean..	24	1.942
Aug. 1	2	1.950 u.
2	-------	-------
3	-------	-------
4	4	1.947 s.—
5	5	1.956 s.
6	4	1.945 s.
7	5	1.939 s.
8	-------	-------
9	-------	-------
10	5	1.930 s.—
	5	1.943
11	-------	-------
12	5	1.927 u.
13	5	1.932 s.
14	4	1.938 s.
15	3	1.933 u.
16	5	1.939 s.—
17	5	1.932 s.
18	5	1.938 s.
19	5	1.941 s.
20	4	1.940 s.
	6	1.937
21	5	1.939 s.
22	5	1.928 s.—

Date	Number of values	S. C. and grade
1928		
Aug. 23	5	1.928 s.—
24	5	1.931 s.—
25	5	1.937 s.—
26	5	1.930 s.—
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
31	-------	-------
	6	1.932
Monthly Mean..	18	1.937
Sept. 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	3	1.918 u.
	-------	-------
11	5	1.935 s.—
12	5	1.918 u.
13	4	1.918 u.
14	2	1.923 u.
15	3	1.912 u.
16	5	1.933 s.—
17	5	1.936 s.
18	-------	-------
19	2	1.941 u.
20	4	1.939 s.
	4	1.938
21	5	1.941 s.
22	1	1.923 u.
23	5	1.923 s.
24	-------	-------
25	5	1.930 s.—
26	5	1.922 u.
27	5	1.919 s.
28	-------	-------
29	5	1.903 s.—
30	5	1.912 s.—
	6	1.921
Monthly mean..	10	1.927
Oct. 1	4	1.930 s.—
2	4	1.928 s.—
3	5	1.937 s.—
4	5	1.936 s.
5	3	1.931 s.—
6	5	1.931 s.
7	5	1.930 s.
8	4	1.931 s.
9	4	1.920 s.
10	5	1.925 s.
	10	1.930

Date	Number of values	S. C. and grade
1928		
Oct. 11	5	1.927 s.
12	5	1.929 s.
13	5	1.935 s.
14	5	1.937 s.
15	5	1.945 s.
16	1	1.955 u.
17	-------	-------
18	5	1.931 s.—
19	4	1.939 s.
20	3	1.923 u.
	7	1.935
21	1	1.935 u.
22	5	1.922 u.
23	-------	-------
24	5	1.928 s.—
25	5	1.938 s.
26	5	1.929 s.
27	5	1.918 s.
28	5	1.923 s.
29′	4	1.927 s.
30	5	1.927 s.
31	5	1.923 s.
	8	1.927
Monthly mean..	25	1.930
Nov. 1	5	1.921 s.
2	5	1.937 s.
3	5	1.915 s.—
4	5	1.920 s.—
5	-------	-------
6	-------	-------
7	-------	-------
8	5	1.927 s.—
9	5	1.925 s.—
10	5	1.926 s.—
	7	1.924
11	2	1.913 u.
12	5	1.925 s.—
13	5	1.922 s.—
14	5	1.928 s.—
15	-------	-------
16	5	1.929 s.—
17	2	1.926 u.
18	5	1.941 s.—
19	4	1.938 s.—
20	5	1.943 s.—
	7	1.932
21	-------	-------
22	4	1.928 u.
23	5	1.929 s.—
24	5	1.932 s.—
25	5	1.923 s.—
26	5	1.923 s.—
27	4	1.929 s.
28	5	1.937 s.—
29	5	1.939 s.—
30	5	1.921 u.
	7	1.930
Monthly mean..	21	1.929

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1928		
Dec. 1	5	1.932 s.—
2	------	------
3	3	1.935 s.—
4	5	1.926 s.—
5	1	1.937 u.
6	5	1.924 s.—
7	5	1.925 s.—
8	5	1.929 s.—
9	3	1.924 u.
10	------	------
	6	1.930
11	------	------
12	2	1.927 u.
13	4	1.925 s.
14	5	1.928 s.—
15	5	1.924 s.—
16	5	1.921 s.—
17	5	1.919 s.
18	5	1.927 s.
19	5	1.923 s.
20	4	1.922 s.
	8	1.924
21	5	1.925 s.—
22	5	1.932 s.—
23	5	1.921 u.
24	5	1.925 s.—
25	5	1.926 s.—
26	------	------
27	2	1.937 u.
28	------	------
29	------	------
30	2	1.914 u.
31	------	------
	4	1.927
Monthly mean	18	1.926
1929		
Jan. 1	------	------
2	3	1.947 u.
3	------	------
4	------	------
5	3	1.944 u.
6	------	------
7	5	1.925 s.—
8	------	------
9	------	------
10	3	1.927 u.
	1	1.925
11	------	------
12	------	------
13	------	------
14	2	1.938 u.
15	5	1.947 s.—
16	5	1.935 s.—
17	4	1.947 s.
18	------	------
19	------	------
20	5	1.935 s.—
	4	1.941

Date	Number of values	S. C. and grade
1929		
Jan. 21	5	1.948 s.—
22	4	1.931 s.—
23	2	1.928 u.
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
31	3	1.938 s.
	3	1.939
Monthly mean	8	1.938
Feb. 1	3	1.929 u.
2	3	1.934 u.
3	2	1.926 u.
4	------	------
5	4	1.927 s.
6	3	1.930 u.
7	5	1.934 s.—
8	5	1.943 s.—
9	5	1.944 s.—
10	5	1.928 u.
	4	1.937
11	5	1.928 s.
12	5	1.936 s.
13	3	1.915 u.
14	4	1.933 s.—
15	3	1.910 u.
16	4	1.905 s.—
17	------	------
18	------	------
19	------	------
20	------	------
	4	1.925
21	5	1.916 u.
22	5	1.912 s.—
23	5	1.926 s.—
24	4	1.927 s.—
25	5	1.936 s.—
26	1	1.910 u.
27	------	------
28	------	------
	4	1.925
Monthly mean	12	1.929
Mar. 1	------	------
2	------	------
3	------	------
4	1	1.933 u.
5	5	1.932 s.—
6	5	1.935 s.—
7	2	1.928 u.
8	5	1.920 u.
9	5	1.930 s.—
10	1	1.914 u.
	3	1.932

Date	Number of values	S. C. and grade
1929		
Mar. 11	2	1.910 u.
12	5	1.928 s.—
13	3	1.930 u.
14	4	1.914 s.
15	5	1.933 s.
16	5	1.935 s.
17	5	1.929 s.
18	5	1.942 s.
19	4	1.931 s.
20	5	1.933 s.
	8	1.931
21	5	1.930 s.
22	5	1.933 s.
23	4	1.937 s.
24	5	1.941 s.
25	5	1.936 s.
26	------	------
27	5	1.927 s.—
28	------	------
29	------	------
30	3	1.915 s.—
31	3	1.933 s.—
	8	1.932
Monthly mean	19	1.931
Apr. 1	5	1.938 s.
2	5	1.940 s.
3	5	1.937 s.
4	5	1.916 s.
5	4	1.931 s.
6	5	1.933 s.
7	5	1.932 s.
8	5	1.929 s.
9	5	1.925 s.
10	5	1.941 s.—
	10	1.932
11	4	1.940 s.
12	5	1.942 s.
13	5	1.948 s.
14	5	1.942 s.
15	5	1.945 s.
16	4	1.945 s.
17	5	1.938 s.
18	5	1.939 s.
19	5	1.938 s.
20	5	1.941 s.
	10	1.942
21	5	1.941 s.
22	4	1.937 s.
23	5	1.944 s.
24	5	1.933 s.
25	5	1.941 s.
26	5	1.940 s.
27	4	1.940 s.
28	5	1.931 s.
29	5	1.931 s.
30	5	1.940 s.
	10	1.938
Monthly mean	30	1.937

Date	Number of values	S. C. and grade
1929		
May 1	5	1.935 s.
2	5	1.938 s.—
3	5	1.940 s.—
4	5	1.940 s.—
5	4	1.937 s.
6	3	1.932 s.—
7	------	------
8	------	------
9	------	------
10	5	1.933 s.—
	7	1.936
11	1	1.941 u.
12	1	1.933 u.
13	3	1.927 u.
14	5	1.952 s.
15	3	1.950 s.—
16	------	------
17	4	1.938 s.
18	5	1.934 s.
19	5	1.936 s.
20	5	1.934 s.—
	6	1.941
21	------	------
22	5	1.951 s.
23	4	1.932 s.
24	5	1.936 s.
25	5	1.938 s.
26	5	1.936 s.
27	5	1.933 s.
28	4	1.936 s.
29	5	1.934 s.
30	5	1.935 s.
31	5	1.936 s.
	10	1.937
Monthly mean	23	1.938
June 1	5	1.935 s.—
2	3	1.940 s.—
3	5	1.940 s.
4	5	1.943 s.—
5	4	1.929 s.
6	5	1.932 s.
7	3	1.947 s.—
8	------	------
9	------	------
10	------	------
	7	1.938
11	5	1.933 s.
12	4	1.924 s.
13	5	1.928 s.—
14	5	1.936 s.—
15	5	1.933 s.
16	------	------
17	------	------
18	------	------
19	------	------
20	3	1.939 s.—
	6	1.932
21	------	------
22	3	1.930 s.

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1929		
June 23	5	1.934 s.
24	4	1.929 s.
25	4	1.933 s.
26	5	1.933 s.
27	------	------
28	------	------
29	5	1.932 s.–
30	5	1.932 s.
	7	1.932
Monthly mean	20	1.934
July 1	4	1.930 s.
2	4	1.943 s.–
3	4	1.940 s.
4	5	1.937 s.
5	5	1.928 s.
6	4	1.928 s.
7	3	1.930 s.–
8	5	1.934 s.
9	5	1.935 s.–
10	5	1.941 s.
	10	1.935
11	4	1.935 s.
12	4	1.933 s.
13	5	1.933 s.
14	5	1.935 s.
15	4	1.931 s.
16	5	1.936 s.
17	5	1.920 s.–
18	4	1.919 s.–
19	5	1.937 s.
20	5	1.927 s.
	10	1.931
21	4	1.931 s.–
22	4	1.930 s.
23	5	1.936 s.
24	5	1.946 s.
25	------	------
26	4	1.939 s.–
27	5	1.929 s.
28	5	1.929 s.
29	------	------
30	4	1.929 s.
31	5	1.937 s.
	9	1.935
Monthly mean	29	1.933
Aug. 1	------	------
2	4	1.929 s.
3	5	1.929 s.
4	5	1.933 s.
5	4	1.929 s.
6	5	1.924 s.
7	5	1.929 s.
8	5	1.933 s.–
9	5	1.937 s.–
10	5	1.937 s.
	9	1.931

Date	Number of values	S. C. and grade
1929		
Aug. 11	5	1.933 s.
12	5	1.934 s.
13	4	1.933 s.
14	5	1.911 u.
15	5	1.930 s.–
16	5	1.904 s.–
17	4	1.928 s.–
18	3	1.931 s.–
19	------	------
20	5	1.938 s.
	8	1.932
21	5	1.937 s.
22	4	1.903 u.
23	5	1.917 u.
24	5	1.928 s.–
25	4	1.931 s.
26	------	------
27	------	------
28	------	------
29	5	1.931 s.–
30	5	1.925 s.–
31	5	1.929 s.
	6	1.930
Monthly mean	23	1.931
Sept. 1	3	1.927 s.–
2	------	------
3	------	------
4	4	1.928 s.
5	5	1.929 s.
6	3	1.928 s.–
7	5	1.922 s.–
8	5	1.924 s.–
9	4	1.926 s.
10	5	1.924 s.–
	8	1.926
11	5	1.924 s.–
12	5	1.922 s.–
13	5	1.929 s.
14	4	1.928 s.
15	5	1.925 s.–
16	5	1.927 s.–
17	2	1.918 u.
18	5	1.932 s.
19	5	1.930 s.–
20	5	1.934 s.–
	9	1.928
21	5	1.924 s.–
22	4	1.924 s.–
23	5	1.936 s.–
24	5	1.933 s.
25	5	1.933 s.–
26	5	1.934 s.–
27	4	1.925 s.–
28	5	1.928 s.–
29	4	1.929 s.–
30	5	1.930 s.–
	10	1.930
Monthly mean	27	1.928

Date	Number of values	S. C. and grade
1929		
Oct. 1	5	1.928 s.–
2	5	1.937 s.
3	5	1.931 s.
4	5	1.927 s.
5	4	1.921 s.
6	5	1.925 s.–
7	5	1.927 s.–
8	5	1.925 s.–
9	5	1.932 s.
10	------	------
	9	1.928
11	5	1.929 s.–
12	------	------
13	------	------
14	3	1.931 s.–
15	2	1.935 u.
16	4	1.939 s.–
17	4	1.934 s.–
18	5	1.933 s.–
19	------	------
20	------	------
	5	1.933
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	3	1.923 s.–
28	5	1.928 s–
29	------	------
30	------	------
31	------	------
	2	1.926
Monthly mean	16	1.929
Nov. 1	5	1.934 s.–
2	5	1.927 s.–
3	5	1.935 s.
4	4	1.926 s.
5	5	1.926 s.–
6	4	1.935 s.–
7	5	1.930 s.–
8	5	1.934 s.–
9	4	1.933 s.
10	5	1.941 s.–
	10	1.932
11	5	1.934 s.
12	5	1.933 s.
13	------	------
14	5	1.940 s.
15	5	1.939 s.–
16	3	1.939 s.–
17	------	------
18	5	1.924 u.
19	1	1.942 u.
20	5	1.931 s.–
	6	1.936
21	5	1.936 s.–
22	------	------

Date	Number of values	S. C. and grade
1929		
Nov. 23	4	1.940 s.–
24	4	1.939 s.–
25	5	1.940 s.–
26	5	1.938 s.
27	5	1.943 s.
28	5	1.939 s.–
29	4	1.940 s.–
30	------	------
	8	1.939
Monthly mean	24	1.936
Dec. 1	------	------
2	3	1.941 s.–
3	1	1.937 u.
4	5	1.940 s.–
5	4	1.943 s.
6	5	1.942 s.–
7	5	1.941 s.–
8	1	1.948 u.
9	5	1.939 s.–
10	5	1.938 s.
	7	1.941
11	4	1.940 s.
12	5	1.951 s.
13	5	1.937 s.
14	5	1.937 s.–
15	------	------
16	4	1.925 s.–
17	------	------
18	3	1.931 s.–
19	4	1.943 s.
20	5	1.946 s.–
	8	1.939
21	5	1.947 s.
22	5	1.952 s.–
23	5	1.936 s.–
24	5	1.934 s.–
25	------	------
26	5	1.935 s.–
27	5	1.931 s.–
28	4	1.942 s.–
29	------	------
30	------	------
31	5	1.943 s.–
	8	1.940
Monthly mean	23	1.940
1930		
Jan. 1	3	1.946 s.–
2	5	1.940 s.–
3	------	------
4	5	1.935 s.–
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	5	1.934 s.–
	4	1.938

TABLE 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1930		
Jan. 11	5	1.939 s.—
12	------	------
13	5	1.931 s.—
14	5	1.938 s.—
15	3	1.938 s.—
16	4	1.928 u.
17	------	------
18	5	1.938 s.—
19	------	------
20	------	------
	5	1.937
21	------	------
22	------	------
23	5	1.922 u.
24	------	------
25	5	1.927 s.—
26	------	------
27	5	1.932 s.— z
28	------	------
29	------	------
30	1	1.922 u.
31	5	1.929 s.—
	3	1.929
Monthly mean	12	1.936
Feb. 1	------	------
2	5	1.931 s.—
3	5	1.931 s.—
4	4	1.934 s.
5	5	1.940 s.—
6	5	1.937 s.—
7	5	1.934 s.—
8	4	1.934 s.—
9	------	------
10	------	------
	7	1.933
11	3	1.943 s.—
12	4	1.935 s.—
13	------	------
14	3	1.938 s.—
15	2	1.916 u.
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	3	1.939
21	------	------
22	5	1.945 s.—
23	5	1.939 s.—
24	4	1.941 s.—
25	5	1.944 s.+
26	5	1.944 s.—
27	------	------
28	5	1.941 s.—
	6	1.942
Monthly mean	16	1.938

Date	Number of values	S. C. and grade
1930		
Mar. 1	2	1.941 s.—
2	5	1.945 s.—
3	5	1.940 s.—
4	4	1.940 s.—
5	5	1.939 s.—
6	5	1.937 s.—
7	------	------
8	------	------
9	4	1.941 s.—
10	5	1.936 s.—
	8	1.940
11	------	------
12	4	1.931 s.—
13	5	1.940 s.—
14	5	1.935 s.—
15	5	1.937 s.—
16	5	1.940 s.—
17	4	1.943 s.—
18	5	1.938 s.—
19	5	1.938 s.
20	5	1.931 s.—
	9	1.937
21	5	1.929 s.—
22	5	1.934 s.—
23	3	1.936 s.—
24	4	1.951 s.—
25	4	1.958 s.
26	5	1.947 s.
27	5	1.939 s.
28	5	1.939 s.—
29	5	1.935 s.—
30	5	1.935 s.—
31	5	1.940 s.—
	11	1.940
Monthly mean	28	1.939
Apr. 1	5	1.940 s.
2	4	1.940 s.
3	5	1.945 s.
4	5	1.938 s.
5	5	1.943 s.—
6	3	1.936 s.—
7	------	------
8	5	1.943 s.—
9	4	1.944 s.
10	5	1.943 s.—
	9	1.941
11	5	1.939 s.
12	5	1.936 s.—
13	1	1.925 u.
14	5	1.943 s.—
15	2	1.940 u.
16	4	1.939 s.
17	5	1.933 s.—
18	3	1.937 s.—
19	5	1.934 s.—
20	5	1.942 s.—
	8	1.938
21	5	1.936 s.—
22	4	1.933 s.

Date	Number of values	S. C. and grade
1930		
Apr. 23	5	1.942 s.—
24	2	1.946 s.—
25	------	------
26	5	1.929 u.
27	5	1.937 s.—
28	4	1.946 s.
29	5	1.948 s.
30	1	1.928 u.
	7	1.941
Monthly mean	24	1.940
May 1	------	------
2	------	------
3	3	1.927 u.
4	5	1.953 s.
5	3	1.939 s.—
6	5	1.947 s.—
7	4	1.941 s.—
8	------	------
9	------	------
10	------	------
	4	1.945
11	------	------
12	------	------
13	------	------
14	------	------
15	------	------
16	1	1.942 u.
17	5	1.942 s.
18	4	1.949 s.
19	5	1.949 s.
20	5	1.952 s.—
	4	1.948
21	5	1.946 s.
22	4	1.951 s.—
23	5	1.940 s.—
24	4	1.939 s.—
25	5	1.936 s.—
26	4	1.944 s.—
27	5	1.944 s.
28	5	1.940 s.
29	5	1.938 s.—
30	3	1.943 s.—
31	5	1.945 s.—
	11	1.942
Monthly mean	19	1.944
June 1	4	1.938 s.—
2	5	1.941 s.—
3	4	1.942 s.
4	5	1.940 s.—
5	5	1.949 s.—
6	5	1.949 s.—
7	4	1.953 s.—
8	5	1.943 s.—
9	5	1.951 s.
10	------	------
	9	1.949

Date	Number of values	S. C. and grade
1930		
June 11	------	------
12	------	------
13	5	1.942 s.—
14	4	1.947 s.
15	5	1.946 s.
16	4	1.944 s.—
17	3	1.945 s.—
18	5	1.943 s.
19	4	1.943 s.—
20	5	1.940 s.
	8	1.944
21	5	1.942 s.—
22	5	1.937 s.—
23	5	1.941 s.—
24	4	1.949 s.
25	5	1.943 s.—
26	5	1.936 s.—
27	5	1.934 s.—
28	4	1.938 s.—
29	5	1.944 s.
30	5	1.946 s.
	10	1.941
Monthly mean	27	1.943
July 1	5	1.951 s.
2	4	1.944 s.
3	3	1.942 s.—
4	5	1.936 s.—
5	5	1.934 s.
6	5	1.944 s.
7	3	1.945 s.—
8	------	------
9	5	1.952 s.—
10	5	1.955 s.
	9	1.945
11	5	1.948 s.—
12	4	1.948 s.
13	5	1.953 s.—
14	1	1.947 u.
15	3	1.956 s.—
16	------	------
17	3	1.951 s.—
18	5	1.951 s.—
19	5	1.944 s.—
20	5	1.944 s.—
	9	1.949
21	5	1.947 s.—
22	4	1.943 s.—
23	5	1.950 s.—
24	5	1.951 s.
25	5	1.953 s.—
26	5	1.943 s.—
27	5	1.940 s.—
28	5	1.934 s.
29	5	1.950 s.—
30	5	1.952 s.
31	4	1.950 s.
	11	1.947
Monthly mean	29	1.947

Table 31.—*Solar-constant values. Short method. Montezuma, 1920–1930*—Continued

Date	Number of values	S. C. and grade
1930		
Aug. 1	5	1.946 s.—
2	2	1.943 s.—
3	5	1.921 u.
4	5	1.923 u.
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	4	1.947 s.—
10	5	1.946 s.
	4	1.946
11	4	1.943 s.
12	-------	-------
13	-------	-------
14	-------	-------
15	5	1.948 s.—
16	4	1.948 s.—
17	5	1.949 s.—
18	-------	-------
19	-------	-------
20	3	1.929 u.
	4	1.947
21	4	1.937 s.
22	5	1.942 s.
23	5	1.936 s.
24	5	1.943 s.
25	5	1.941 s.
26	4	1.948 s.
27	5	1.948 s.
28	3	1.946 s.—
29	5	1.947 s.
30	5	1.943 s.—
31	4	1.940 s.—
	11	1.943
Monthly mean	19	1.945
Sept. 1	5	1.950 s.
2	5	1.953 s.
3	5	1.948 s.
4	5	1.948 s.—
5	4	1.948 s.
6	5	1.942 s.
7	5	1.942 s.
8	5	1.936 s.
9	5	1.925 s.—
10	4	1.924 s.—
	10	1.942

Date	Number of values	S. C. and grade
1930		
Sept. 11	1	1.925 s.—
12	5	1.929 s.—
13	3	1.925 u.
14	5	1.925 u.
15	-------	-------
16	5	1.934 s.—
17	3	1.949 u.
18	-------	-------
19	3	1.924 u.
20	-------	-------
	3	1.929
21	-------	-------
22	-------	-------
23	-------	-------
24	3	1.946 s.
25	5	1.935 s.
26	4	1.941 s.
27	2	1.930 u.
28	-------	-------
29	5	1.940 s.—
30	5	1.933 s.—
	5	1.939
Monthly mean	18	1.937
Oct. 1	4	1.942 s.
2	5	1.944 s.
3	5	1.943 s.
4	5	1.942 s.
5	5	1.930 s.
6	5	1.938 s.—
7	-------	-------
8	5	1.930 s.—
9	4	1.937 s.
10	5	1.943 s.—
	9	1.939
11	5	1.946 s.
12	3	1.942 u.
13	5	1.941 s.—
14	4	1.942 s.—
15	4	1.948 s.—
16	5	1.943 s.
17	4	1.939 s.—
18	-------	-------
19	-------	-------
20	5	1.929 s.—
	7	1.941
21	-------	-------
22	5	1.943 s.—

Date	Number of values	S. C. and grade
1930		
Oct. 23	4	1.938 s.
24	5	1.942 s.—
25	5	1.944 s.
26	3	1.941 s.—
27	5	1.940 s.—
28	5	1.936 s.—
29	5	1.931 s.—
30	4	1.941 s.
31	5	1.938 s.—
	10	1.939
Monthly mean	26	1.940
Nov. 1	5	1.939 s.—
2	-------	-------
3	1	1.916 u.
4	1	1.912 u.
5	2	1.933 u.
6	5	1.941 s.—
7	5	1.948 s.—
8	3	1.933 u.
9	4	1.938 s.
10	5	1.945 s.—
	5	1.943
11	4	1.941 s.—
12	3	1.939 s.—
13	5	1.942 s.—
14	4	1.938 s.
15	5	1.942 s.—
16	-------	-------
17	5	1.943 s.—
18	5	1.946 s.
19	4	1.949 s.
20	5	1.943 s.
	8	1.943
21	5	1.944 s.—
22	1	1.934 u.
23	-------	-------
24	-------	-------
25	-------	-------
26	4	1.950 s.—
27	5	1.953 s.—
28	5	1.947 s.—
29	5	1.939 u.
30	4	1.950 s.
	5	1.949
Monthly mean	19	1.944

Date	Number of values	S. C. and grade
1930		
Dec. 1	5	1.945 s.
2	5	1.943 s.
3	5	1.949 s.
4	5	1.948 s.—
5	4	1.942 s.
6	5	1.949 s.—
7	5	1.948 s.
8	5	1.943 s.—
9	3	1.946 s.—
10	3	1.941 s.—
	10	1.945
11	5	1.944 s.—
12	4	1.948 s.
13	5	1.950 s.
14	5	1.953 s.
15	5	1.949 s.
16	5	1.951 s.—
17	4	1.949 s.
18	5	1.946 s.—
19	5	1.945 s.—
20	5	1.942 s.—
	10	1.948
21	3	1.944 s.—
22	3	1.946 s.—
23	2	1.941 u.
24	5	1.956 s.—
25	4	1.958 s.—
26	5	1.949 s.—
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
31	-------	-------
	5	1.945
Monthly mean	25	1.947

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*

Date	Number of values	S. C. and grade
1925		
Dec. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	2	1.942 s.−
7	2	1.959 u.+
8	3	1.932 s.−
9	2	1.943 s.−
10	2	1.922 u.+
	5	1.940
11	2	1.922 u.
12	------	------
13	2	1.903 u.
14	2	1.927 u.+
15	1	1.953 u.+
16	2	1.931 s.−
17	------	------
18	------	------
19	------	------
20	2	1.916 u.
	3	1.937
21	------	------
22	3	1.915 u.
23	------	------
24	------	------
25	3	1.920 u.
26	2	1.938 u.+
27	------	------
28	------	------
29	------	------
30	------	------
31	------	------
	1	1.938
Monthly mean	9	1.940
1926		
Jan. 1	------	------
2	2	1.931 s.−
3	------	------
4	2	1.915 u.
5	2	1.935 s.−
6	3	1.924 s.−
7	2	1.930 u.
8	2	1.937 s.−
9	2	1.931 s.−
10	------	------
	5	1.935
11	2	1.936 s.−
12	2	1.926 s.−
13	------	------
14	2	1.937 u.
15	3	1.947 s.−
16	2	1.936 s.−
17	3	1.918 u.
18	2	1.912 u.
19	3	1.944 s.−
20	3	1.928 s.−
	6	1.939

Date	Number of values	S. C. and grade
1926		
Jan. 21	2	1.942 u.+
22	------	------
23	2	1.918 u.
24	3	1.920 u.+
25	2	1.920 s.−
26	2	1.926 s.−
27	2	1.937 s.−
28	2	1.933 s.−
29	------	------
30	------	------
31	------	------
	5	1.935
Monthly mean	16	1.938
Feb. 1	------	------
2	------	------
3	2	1.924 s.−
4	------	------
5	------	------
6	1	1.932 u.+
7	------	------
8	------	------
9	2	1.937 s.−
10	------	------
	3	1.934
11	------	------
12	------	------
13	------	------
14	2	1.952 s.−
15	------	------
16	3	1.931 s.−
17	3	1.930 u.+
18	------	------
19	------	------
20	------	------
	3	1.940
21	3	1.952 s.−
22	3	1.933 u.+
23	3	1.921 s.−
24	2	1.920 u.+
25	3	1.938 s.−
26	3	1.917 u.+
27	3	1.925 s.−
28	3	1.918 s.−
	8	1.930
Monthly mean	14	1.932
Mar. 1	------	------
2	3	1.930 s.−
3	------	------
4	------	------
5	2	1.929 s.−
6	2	1.926 s.−
7	------	------
8	------	------
9	------	------
10	3	1.932 u.+
	4	1.931

Date	Number of values	S. C. and grade
1926		
Mar. 11	3	1.928 s.−
12	3	1.926 s.−
13	------	------
14	3	1.940 s.−
15	------	------
16	3	1.897 u.
17	2	1.930 s.−
18	------	------
19	------	------
20	------	------
	4	1.933
21	------	------
22	3	1.923 s.−
23	3	1.937 u.+
24	3	1.940 s.−
25	2	1.936 s.−
26	3	1.948 s.−
27	3	1.933 s.−
28	------	------
29	------	------
30	3	1.973 u.
31	3	1.950 s.−
	7	1.940
Monthly mean	12	1.932
Apr. 1	2	1.953 s.−
2	------	------
3	3	1.940 s.−
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	2	1.894 u.
	2	1.946
11	3	1.946 s.−
12	------	------
13	------	------
14	3	1.933 s.−
15	2	1.926 s.−
16	2	1.903 u.
17	2	1.932 s.−
18	------	------
19	------	------
20	1	1.923 s.−
	5	1.932
21	2	1.948 s.−
22	3	1.952 u.+
23	3	1.939 u.+
24	3	1.944 u.+
25	------	------
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
	4	1.946
Monthly mean	11	1.940

Date	Number of values	S. C. and grade
1926		
May 1	------	------
2	------	------
3	3	1.920 u.
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	------	------
11	3	1.912 u.
12	3	1.934 u.+
13	3	1.932 s.−
14	3	1.930 s.−
15	3	1.940 s.−
16	3	1.955 s.−
17	3	1.950 s.−
18	------	------
19	3	1.939 s.−
20	2	1.952 s.−
	8	1.937
21	2	1.942 s.−
22	------	------
23	3	1.951 s.−
24	------	------
25	------	------
26	3	1.876 u.
27	------	------
28	------	------
29	------	------
30	3	1.906 u.
31	2	1.907 u.
	2	1.946
Monthly mean	10	1.942
June 1	1	1.922 u.
2	3	1.952 u.+
3	3	1.926 u.
4	3	1.908 u.
5	------	------
6	------	------
7	------	------
8	------	------
9	3	1.912 u.
10	3	1.948 s.−
	2	1.950
11	3	1.908 u.
12	3	1.930 s.−
13	3	1.958 s.−
14	3	1.934 s.−
15	3	1.958 s.−
16	3	1.934 s.−
17	------	------
18	5	1.936 s.−
19	3	1.943 s.−
20	5	1.940 s.−
	8	1.938
21	3	1.945 s.−
22	4	1.938 s.−

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1926		
June 23	5	1.930 s.−
24	-------	-------
25	3	1.931 s.−
26	-------	-------
27	-------	-------
28	5	1.944 s.−
29	1	1.905 u.
30	3	1.930 s.−
	6	1.936
Monthly mean	16	1.941
July 1	3	1.933 s.−
2	5	1.932 s.−
3	3	1.952 s.−
4	-------	-------
5	-------	-------
6	5	1.943 s.−
7	3	1.965 u.
8	3	1.931 s.−
9	4	1.929 s.−
10	5	1.938 s.−
	7	1.937
11	5	1.940 s.−
12	5	1.950 s.−
13	5	1.960 s.−
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	5	1.932 s.−
20	5	1.931 s.−
	5	1.943
21	3	1.935 s.−
22	5	1.935 s.−
23	3	1.940 s.−
24	5	1.926 s.−
25	5	1.928 s.−
26	5	1.935 s.−
27	5	1.937 s.−
28	3	1.930 u.+
29	5	1.923 s.−
30	3	1.945 s.−
31	3	1.946 s.−
	11	1.935
Monthly mean	21	1.937
Aug. 1	3	1.953 s.−
2	-------	-------
3	-------	-------
4	-------	-------
5	5	1.934 s.−
6	-------	-------
7	-------	-------
8	2	1.910 u.
9	5	1.936 s.−
10	3	1.933 s.−
	4	1.939

Date	Number of values	S. C. and grade
1926		
Aug. 11	5	1.949 s.−
12	-------	-------
13	5	1.937 s.−
14	5	1.958 u.
15	4	1.929 s.−
16	5	1.928 u.+
17	5	1.947 s.−
18	5	1.941 s.−
19	5	1.927 s.−
20	5	1.941 s.−
	8	1.937
21	5	1.956 s.−
22	5	1.940 s.−
23	5	1.932 u.+
24	5	1.922 u.
25	-------	-------
26	3	1.946 u.+
27	-------	-------
28	5	1.941 s.−
29	5	1.949 s.−
30	5	1.947 s.−
31	5	1.969 u.
	7	1.944
Monthly mean	18	1.941
Sept. 1	5	1.948 s.−
2	5	1.948 s.−
3	3	1.943 s.−
4	3	1.934 s.−
5	5	1.936 u.+
6	-------	-------
7	5	1.934 s.−
8	5	1.936 s.−
9	5	1.941 s.−
10	5	1.937 s.−
	9	1.939
11	5	1.930 s.−
12	5	1.938 s.−
13	5	1.937 s.−
14	5	1.938 s.−
15	5	1.942 s.−
16	5	1.945 s.−
17	3	1.949 s.−
18	5	1.952 s.−
19	5	1.934 s.−
20	5	1.934 s.−
	10	1.939
21	5	1.942 s.−
22	5	1.938 s.−
23	5	1.946 s.−
24	3	1.956 s.−
25	5	1.947 u.+
26	5	1.948 s.−
27	5	1.941 s.−
28	3	1.962 u.
29	5	1.963 s.−
30	5	1.937 s.−
	9	1.945
Monthly mean	27	1.940

Date	Number of values	S. C. and grade
1926		
Oct. 1	5	1.907 u.
2	5	1.943 s.−
3	5	1.946 s.−
4	3	1.938 s.−
5	4	1.933 s.−
6	5	1.939 s.−
7	3	1.933 s.−
8	5	1.949 s.−
9	5	1.944 s.−
10	4	1.938 s.−
	9	1.939
11	4	1.935 s.−
12	3	1.948 s.−
13	4	1.944 s.−
14	5	1.932 s.−
15	5	1.933 s.−
16	3	1.942 s.−
17	5	1.930 s.−
18	5	1.935 s.−
19	3	1.962 u.
20	4	1.948 s.−
	9	1.938
21	3	1.944 u.+
22	2	1.910 u.
23	5	1.932 s.−
24	5	1.928 s.−
25	5	1.927 s.−
26	3	1.937 s.−
27	5	1.935 s.−
28	5	1.930 s.−
29	5	1.935 s.−
30	3	1.933 s.−
31	5	1.926 s.−
	10	1.932
Monthly mean	28	1.936
Nov. 1	5	1.933 s.−
2	5	1.930 s.−
3	5	1.928 s.−
4	2	1.940 s.−
5	-------	-------
6	2	1.937 s.−
7	5	1.948 s.−
8	5	1.943 s.−
9	5	1.948 s.−
10	-------	-------
	8	1.937
11	3	1.932 s.−
12	-------	-------
13	5	1.950 u.
14	5	1.938 s.−
15	5	1.940 s.−
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	5	1.935 s.−
	4	1.935
21	5	1.937 s.−
22	-------	-------

Date	Number of values	S. C. and grade
1926		
Nov. 23	-------	-------
24	-------	-------
25	1	1.899 u.
26	-------	-------
27	1	1.968 u.
28	5	1.934 s.−
29	-------	-------
30	1	1.934 u.+
	4	1.934
Monthly mean	16	1.937
Dec. 1	1	1.946 u.+
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	3	1.912 u.
7	-------	-------
8	-------	-------
9	-------	-------
10	2	1.922 u.
	1	1.946
11	2	1.952 s.−
12	5	1.950 s.−
13	5	1.946 s.−
14	5	1.952 s.−
15	5	1.948 s.−
16	5	1.949 s.−
17	-------	-------
18	-------	-------
19	5	1.941 s.−
20	5	1.942 s.−
	8	1.947
21	-------	-------
22	2	1.937 s.−
23	-------	-------
24	5	1.944 s.−
25	4	1.934 s.−
26	1	1.926 u.
27	5	1.931 s.−
28	5	1.947 s.−
29	5	1.941 s.−
30	5	1.935 s.−
31	5	1.934 s.−
	8	1.938
Monthly mean	17	1.943
1927		
Jan. 1	5	1.936 s.−
2	5	1.941 s.−
3	-------	-------
4	-------	-------
5	5	1.932 s.−
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	3	1.941

Table 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1927		
Jan. 11	3	1.952 u.+
12	3	1.953 s.−
13	5	1.947 s.−
14	-------	-------
15	-------	-------
16	5	1.967 u.
17	3	1.942 s.−
18	5	1.938 s.−
19	-------	-------
20	-------	-------
	5	1.949
21	-------	-------
22	-------	-------
23	3	1.934 s.−
24	5	1.939 u.+
25	-------	-------
26	-------	-------
27	5	1.970 u.
28	-------	-------
29	-------	-------
30	3	1.969 u.
31	5	1.941 u.+
	3	1.941
Monthly Mean	11	1.944
Feb. 1	3	1.934 s.−
2	5	1.933 s.−
3	-------	-------
4	-------	-------
5	-------	-------
6	5	1.925 s.−
7	3	1.945 u.+
8	5	1.949 s.−
9	-------	-------
10	-------	-------
	5	1.939
11	-------	-------
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	5	1.947 s.−
18	5	1.939 s.−
19	-------	-------
20	-------	-------
	2	1.945
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	3	1.948 s.−
26	-------	-------
27	3	1.975 u.
28	3	1.937 s.−
	2	1.944
Monthly Mean	9	1.942

Date	Number of values	S. C. and grade
1927		
Mar. 1	-------	-------
2	5	1.947 s.−
3	-------	-------
4	-------	-------
5	-------	-------
6	5	1.950 s.−
7	3	1.931 s.−
8	4	1.940 s.−
9	-------	-------
10	-------	-------
	4	1.943
11	4	1.929 u.
12	5	1.941 s.−
13	3	1.943 s.−
14	5	1.935 s.−
15	5	1.947 s.−
16	-------	-------
17	-------	-------
18	5	1.952 s.−
19	3	1.941 s.−
20	-------	-------
	6	1.944
21	5	1.918 u.
22	5	1.945 s.−
23	5	1.938 s.−
24	3	1.956 s.−
25	5	1.958 s.−
26	3	1.947 s.−
27	2	1.952 u.
28	-------	-------
29	-------	-------
30	-------	-------
31	-------	-------
	5	1.950
Monthly Mean	14	1.945
Apr. 1	5	1.950 u.+
2	3	1.945 u.
3	2	1.958 u.
4	3	1.958 s.−
5	5	1.960 u.
6	5	1.958 u.
7	5	1.948 s.−
8	5	1.949 s.−
9	-------	-------
10	3	1.949 s.−
	5	1.951
11	-------	-------
12	-------	-------
13	5	1.926 u.
14	3	1.941 s.−
15	4	1.951 s.−
16	5	1.955 s.−
17	3	1.941 s.−
18	3	1.940 s.−
19	5	1.967 u.
20	5	1.927 u.
	5	1.946

Date	Number of values	S. C. and grade
1927		
Apr. 21	5	1.951 s.−
22	5	1.953 s.−
23	3	1.936 s.−
24	5	1.930 s.−
25	5	1.937 s.−
26	3	1.934 s.−
27	4	1.955 s.−
28	3	1.954 s.−
29	5	1.943 s.−
30	5	1.942 s.−
	10	1.943
Monthly Mean	20	1.945
May 1	5	1.957 u.
2	5	1.943 s.−
3	3	1.941 s.−
4	5	1.954 s.−
5	5	1.928 u.
6	3	1.967 u.
7	-------	-------
8	5	1.938 s.−
9	5	1.951 s.−
10	3	1.945 u.+
	6	1.945
11	5	1.946 s.−
12	5	1.950 s.−
13	3	1.947 s.−
14	-------	-------
15	5	1.945 s.−
16	5	1.976 u.
17	3	1.959 u.
18	5	1.951 s.−
19	5	1.958 u.
20	5	1.960 u.
	5	1.948
21	5	1.939 s.−
22	5	1.942 s.−
23	5	1.946 s.−
24	5	1.960 s.−
25	3	1.958 s.−
26	5	1.960 s.−
27	5	1.932 s.−
28	5	1.937 s.−
29	5	1.948 s.−
30	5	1.942 s.−
31	3	1.954 s.−
	11	1.943
Monthly mean	20	1.945
June 1	5	1.977 u.
2	-------	-------
3	5	1.946 s.−
4	-------	-------
5	5	1.958 s.−
6	-------	-------
7	5	1.962 s.−
8	5	1.961 s.−
9	5	1.949 s.−
10	-------	-------
	5	1.955

Date	Number of values	S. C. and grade
1927		
June 11	5	1.950 s.−
12	4	1.954 s.−
13	5	1.996 u.
14	-------	-------
15	-------	-------
16	5	1.940 s.−
17	5	1.950 s.−
18	5	1.890 u.
19	5	1.965 u.
20	3	1.960 u.
	4	1.948
21	5	1.944 s.−
22	5	1.938 s.−
23	5	1.947 s.−
24	5	1.948 s.−
25	-------	-------
26	4	1.960 s.−
27	5	1.947 s.−
28	3	1.946 s.−
29	5	1.949 s.−
30	5	1.956 u.+
	10	1.943
Monthly mean	14	1.948
July 1	5	1.946 s.−
2	5	1.956 s.−
3	5	1.946 s.−
4	5	1.944 s.−
5	5	1.950 s.−
6	5	1.945 s.−
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	6	1.946
11	5	1.947 s.−
12	5	1.949 s.−
13	5	1.945 s.−
14	5	1.952 s.−
15	5	1.948 s.−
16	5	1.956 u.
17	5	1.941 s.−
18	3	1.943 u.+
19	4	1.945 u.+
20	-------	-------
	8	1.946
21	-------	-------
22	3	1.948 u.+
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	3	1.949 s.−
29	5	1.948 u.+
30	5	1.946 s.−
31	5	1.948 s.−
	5	1.950
Monthly mean	18	1.947

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1927		
Aug. 1	-------	-------
2	2	1.949 s.—
3	5	1.946 s.—
4	3	1.942 s.—
5	-------	-------
6	5	1.966 u.
7	3	1.954 s.—
8	3	1.949 u.
9	3	1.954 s.—
10	5	1.953 s.—
	6	1.950
11	5	1.952 s.—
12	5	1.954 s.—
13	5	1.974 u.
14	3	1.973 u.
15	3	1.931 s.—
16	-------	-------
17	-------	-------
18	2	1.962 u.
19	-------	-------
20	-------	-------
	3	1.946
21	3	1.939 s.—
22	5	1.948 s.—
23	3	1.943 s.—
24	5	1.942 s.—
25	5	1.936 s.—
26	5	1.941 s.—
27	1	(1.944) s.—
28	-------	-------
29	3	1.950 s.—
30	5	1.957 s.—
31	3	1.946 s.—
	10	1.946
Monthly mean	19	1.946
Sept. 1	4	1.954 s.—
2	5	1.954 s.—
3	-------	-------
4	3	1.960 u.+
5	5	1.955 s.—
6	5	1.958 s.—
7	5	1.945 s.—
8	5	1.950 s.—
9	3	1.960 u.+
10	5	1.956 s.—
	9	1.954
11	5	1.954 s.—
12	5	1.947 s.—
13	2	1.950 s.—
14	5	1.969 u.
15	5	1.933 u.+
16	5	1.964 u.
17	3	1.960 s.—
18	5	1.934 s.—
19	5	1.943 s.—
20	3	1.937 s.—
	8	1.945
21	2	1.941 s.—
22	3	1.935 s.—
1927		
Sept. 23	5	1.948 s.—
24	5	1.947 s.—
25	5	1.955 s.—
26	5	1.951 s.—
27	5	1.951 s.—
28	5	1.944 s.—
29	3	1.952 s.—
30	4	1.953 u.+
	10	1.947
Monthly Mean	23	1.947
Oct. 1	5	1.959 s.—
2	5	1.943 s.—
3	5	1.954 s.—
4	5	1.950 s.—
5	5	1.954 s.—
6	3	1.948 s.—
7	5	1.948 s.—
8	5	1.943 s.—
9	5	1.933 s.—
10	5	1.944 s.—
	10	1.947
11	5	1.946 s.—
12	5	1.954 s.—
13	3	1.934 s.—
14	4	1.879 u.
15	5	1.942 s.—
16	5	1.949 s.—
17	3	1.945 s.—
18	3	1.946 s.—
19	2	1.944 s.—
20	5	1.946 s.—
	9	1.944
21	5	1.945 s.—
22	5	1.944 s.—
23	5	1.943 s.—
24	5	1.938 s.—
25	-------	-------
26	-------	-------
27	-------	-------
28	4	1.958 u.
29	5	1.951 s.—
30	5	1.950 s.—
31	-------	-------
	6	1.944
Monthly mean	22	1.944
Nov. 1	5	1.938 s.—
2	2	1.937 s.—
3	5	1.941 s.—
4	5	1.938 s.—
5	-------	-------
6	-------	-------
7	2	1.950 s.—
8	5	1.955 s.—
9	-------	-------
10	5	1.945 s.—
	7	1.941
1927		
Nov. 11	2	1.941 s.—
12	5	1.948 s.—
13	-------	-------
14	2	1.930 u.+
15	5	1.940 s.—
16	5	1.940 s.—
17	5	1.947 s.—
18	2	1.936 s.—
19	-------	-------
20	-------	-------
	7	1.939
21	-------	-------
22	5	1.941 s.—
23	2	1.943 s.—
24	5	1.943 s.—
25	5	1.941 s.—
26	-------	-------
27	1	1.941 u.+
28	5	1.945 s.—
29	5	1.952 s.—
30	1	1.968 u.
	6	1.943
Monthly mean	21	1.941
Dec. 1	4	1.936 s.—
2	5	1.932 s.—
3	5	1.940 s.—
4	5	1.931 s.—
5	5	1.932 s.—
6	2	1.936 s.—
8	5	1.942 s.—
7	5	1.936 s.—
9	5	1.944 s.—
10	-------	-------
	9	1.937
11	-------	-------
12	2	1.935 s.—
13	-------	-------
14	-------	-------
15	5	1.936 s.—
16	5	1.932 s.—
17	5	1.933 s.—
18	5	1.938 s.—
19	2	1.942 s.—
20	-------	-------
	6	1.936
21	-------	-------
22	5	1.945 s.—
23	5	1.953 u.
24	-------	-------
25	-------	-------
26	-------	-------
27	1	1.951 u.+
28	-------	-------
29	-------	-------
30	5	1.939 s.—
31	2	1.926 u.
	3	1.945
Monthly mean	19	1.937
1928		
Jan. 1	3	1.928 u.+
2	-------	-------
3	1	1.918 u.
4	5	1 929 s.—
5	1	1.933 s.—
6	5	1.934 s.—
7	-------	-------
8	-------	-------
9	2	1.923 s.—
10	-------	-------
	5	1.932
11	5	1.938 s.—
12	5	1.937 s.—
13	5	1.934 s.—
14	5	1.945 u.+
15	-------	-------
16	4	1.931 s.—
17	-------	-------
18	2	1.926 s.—
19	5	1.935 s.—
20	2	1.928 s.—
	8	1.937
21	5	1.936 s.—
22	5	1.932 s.—
23	4	1.915 u.
24	5	1.925 s.—
25	-------	-------
26	5	1.918 u.
27	1	1.920 u.
28	4	1.938 s.—
29	-------	-------
30	-------	-------
31	5	1.939 s.—
	5	1.937
Monthly mean	18	1.935
Feb. 1	5	1.938 s.—
2	1	1.936 u.+
3	-------	-------
4	-------	-------
5	5	1.936 s.—
6	2	1.956 u.+
7	-------	-------
8	2	1.954 u.+
9	3	1.900 u.
10	2	1.937 u.+
	6	1.945
11	5	1.938 s.—
12	5	1.937 s.—
13	-------	-------
14	2	1.945 u.+
15	3	1.938 s.—
16	5	1.949 s.—
17	2	1.927 s.—
18	5	1.938 s.—
19	-------	-------
20	5	1.937 s.—
	8	1.941
21	4	1.942 s.—
22	4	1.931 s.—

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1928		
Feb. 23	5	1.943 s.—
24	-------	-------
25	5	1.938 s.—
26	5	1.939 s.—
27	2	1.941 s.—
28	3	1.938 s.—
29	5	1.941 s.—
	8	1.941
Monthly mean	21	1.942
Mar. 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	2	1.924 u.
7	3	1.950 s.—
8	5	1.948 s.—
9	2	1.965 u.+
10	-------	-------
	3	1.955
11	-------	-------
12	-------	-------
13	5	1.956 s.—
14	5	1.960 s.—
15	-------	-------
16	5	1.940 s.—
17	5	1.947 s.—
18	5	1.940 s.—
19	3	1.927 u.
20	5	1.911 u.
	5	1.950
21	5	1.937 s.—
22	-------	-------
23	3	1.935 s.—
24	-------	-------
25	4	1.949 s.—
26	3	1.941 s.—
27	3	1.954 s.—
28	2	1.941 s.—
29	3	1.938 s.—
30	5	1.930 s.—
31	-------	-------
	8	1.942
Monthly mean	16	1.947
Apr. 1	5	1.937 s.—
2	5	1.946 s.—
3	-------	-------
4	5	1.943 s.—
5	-------	-------
6	-------	-------
7	5	1.946 s.—
8	5	1.939 s.—
9	5	1.924 u.
10	-------	-------
	5	1.942
11	-------	-------
12	2	1.932 s.—

Date	Number of values	S. C. and grade
1928		
Apr. 13	3	1.925 u.
14	-------	-------
15	5	1.942 s.—
16	2	1.948 s.—
17	4	1.945 s.—
18	4	1.955 u.
19	4	1.942 s.—
20	4	1.966 u.
	5	1.942
21	3	1.957 u +
22	-------	-------
23	5	1.955 s.—
24	5	1.959 s.—
25	5	1.988 u.
26	5	1.953 s.—
27	-------	-------
28	-------	-------
29	5	1.993 u.
30	5	1.953 s.—
	5	1.955
Monthly mean	15	1.946
May 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	5	1.957 u.+
8	5	1.974 u.
9	-------	-------
10	-------	-------
	-------	-------
11	-------	-------
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	2	1.907 u.
18	-------	-------
19	-------	-------
20	-------	-------
	-------	-------
21	-------	-------
22	-------	-------
23	-------	-------
24	1	1.975 u.
25	-------	-------
26	1	1.981 u.
27	5	1.972 u.
28	5	1.980 u.
29	3	1.943 u.+
30	5	1.964 u.+
31	5	1.963 u.+
	-------	-------
Monthly Mean.	No trustworthy values.	

Date	Number of values	S. C. and grade
1928		
June 1	5	1.963 u.+
2	5	1.973 u.
3	2	1.975 u.
4	5	1.980 u.
5	4	1.976 u.
6	3	1.947 u.+
7	5	1.952 s.—
8	5	1.965 u.
9	5	1.968 u.
10	5	1.969 u.
	3	1.954
11	5	1.967 u.
12	3	1.970 u.
13	5	1.966 u.
14	5	1.959 s.—
15	5	1.963 s.—
16	5	1.956 s.—
17	5	1.964 s.—
18	3	1.974 u.
19	5	1.965 u.
20	5	1.961 s.—
	5	1.961
21	5	1.956 s.—
22	3	1.949 s.—
23	5	1.943 s.—
24	5	1.931 s.—
25	5	1.949 s.—
26	5	1.951 s.—
27	3	1.944 s.—
28	5	1.947 s.—
29	5	1.939 s.—
30	5	1.948 s.—
	10	1.946
Monthly mean	17	1.951
July 1	5	1.930 u.+
2	5	1.942 s.—
3	3	1.933 s.—
4	5	1.944 s.—
5	5	1.941 s.—
6	4	1.961 s.—
7	5	1.954 s.—
8	5	1.950 s.—
9	5	1.940 s.—
10	3	1.944 s.—
	10	1.944
11	5	1.915 s.—
12	5	1.913 u.
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	5	1.962 s.—
18	5	1.946 s.—
19	3	1.942 s.—
20	5	1.931 s.—
	5	1.939
21	5	1.932 s.—
22	5	1.940 s.—

Date	Number of values	S. C. and grade
1928		
July 23	3	1.938 s.—
24	5	1.928 s.—
25	5	1.902 u.
26	-------	-------
27	-------	-------
28	1	1.954 u.
29	5	1.902 u.
30	-------	-------
31	-------	-------
	4	1.935
Monthly mean	18	1.942
Aug. 1	3	1.928 s.—
2	5	1.934 s.—
3	3	1.929 s.—
4	5	1.942 s.—
5	5	1.942 s.—
6	5	1.937 s.—
7	3	1.936 s.—
8	5	1.912 u.
9	5	1.901 u.
10	5	1.908 u.
	7	1.935
11	5	1.890 u.
12	-------	-------
13	-------	-------
14	-------	-------
15	5	1.922 u.
16	5	1.940 s.—
17	5	1.943 s.—
18	4	1.936 s.—
19	5	1.942 s.—
20	5	1.932 s.—
	5	1.939
21	-------	-------
22	3	1.923 s.—
23	-------	-------
24	-------	-------
25	3	1.930 s.—
26	5	1.949 s.—
27	5	1.943 s.—
28	5	1.957 u.+
29	-------	-------
30	5	1.946 s.—
31	3	1.941 s.—
	7	1.941
Monthly mean	18	1.937
Sept. 1	5	1.943 s.—
2	5	1.931 u.+
3	5	1.941 u.+
4	5	1.939 u.+
5	5	1.940 s.—
6	3	1.954 u.
7	1	1.931 u.
8	5	1.970 u.
9	5	1.970 u.
10	5	1.984 u.
	6	1.937

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1928		
Sept. 11	3	1.925 u.
12	5	1.937 s.—
13	5	1.962 u.
14	5	1.938 s.—
15	3	1.919 u.
16	-------	-------
17	5	1.937 s.—
18	3	1.935 s.—
19	4	1.918 s.—
20	5	1.940 s.—
	6	1.933
21	3	1.941 s.—
22	-------	-------
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	5	1.915 s.—
28	5	1.897 u.
29	5	1.906 u.+
30	3	1.922 s.—
	3	1.924
Monthly Mean..	15	1.933
Oct. 1	5	1.920 s.—
2	5	1.928 s.—
3	3	1.928 s.—
4	5	1.933 s.—
5	5	1.933 s.—
6	5	1.952 u.
7	5	1.927 s.—
8	3	1.919 s.—
9	5	1.927 s.—
10	5	1.929 s.—
	9	1.926
11	-------	-------
12	-------	-------
13	-------	-------
14	5	1.920 s.—
15	3	1.927 s.—
16	-------	-------
17	-------	-------
18	4	1.922 s.—
19	4	1.921 s.—
20	5	1.928 s.—
	5	1.923
21	5	1.921 s.—
22	3	1.924 s.—
23	-------	-------
24	-------	-------
25	4	1.926 s.—
26	-------	-------
27	1	1.950 u.
28	5	1.932 s.—
29	2	1.908 u.
30	5	1.931 s.—
31	5	1.932 s.—
	6	1.927
Monthly mean..	20	1.925

Date	Number of values	S. C. and grade
1928		
Nov. 1	-------	-------
2	-------	-------
3	-------	-------
4	3	1.927 s.—
5	5	1.943 s.—
6	5	1.925 s.—
7	5	1.929 s.—
8	2	1.944 u.+
9	5	1.929 s.—
10	-------	-------
	6	1.932
11	5	1.935 s.—
12	4	1.939 s.—
13	5	1.940 s.—
14	-------	-------
15	-------	-------
16	2	1.925 s.—
17	5	1.935 s.—
18	5	1.921 s.—
19	5	1.939 s.—
20	2	1.923 s.—
	8	1.931
21	-------	-------
22	5	1.925 s.—
23	-------	-------
24	-------	-------
25	5	1.923 s.—
26	5	1.933 s.—
27	2	1.939 s.—
28	2	1.929 s.—
29	5	1.915 u.
30	5	1.927 s.—
	6	1.928
Monthly mean..	18	1.929
Dec. 1	5	1.930 s.—
2	-------	-------
3	-------	-------
4	3	1.951 u.
5	-------	-------
6	5	1.922 s.—
7	2	1.920 s.—
8	2	1.928 s.—
9	2	1.928 s.—
10	2	1.930 s.—
	6	1.926
11	5	1.938 s.—
12	5	1.928 s.—
13	-------	-------
14	-------	-------
15	5	1.917 s.—
16	2	1.917 s.—
17	2	1.935 s.—
18	2	1.930 s.—
19	2	1.937 s.—
20	2	1.939 s.—
	8	1.930
21	2	1.945 s.—
22	2	1.930 s.—

Date	Number of values	S. C. and grade
1928		
Dec. 23	2	1.936 s.—
24	5	1.943 s.—
25	5	1.938 s.—
26	2	1.927 s.—
27	-------	-------
28	2	1.925 s.—
29	2	1.941 s.—
30	2	1.942 s.—
31	2	1.928 s.—
	10	1.936
Monthly mean..	24	1.9 1
1929		
Jan. 1	4	1.926 s.—
2	-------	-------
3	5	1.935 s.—
4	-------	-------
5	-------	-------
6	-------	-------
7	4	1.933 s.—
8	2	1.922 s.—
9	2	1.931 s.—
10	2	1.922 s.—
	6	1.930
11	2	1.922 s.—
12	2	1.918 s.—
13	-------	-------
14	2	1.954 u.
15	-------	-------
16	-------	-------
17	2	1.916 u.+
18	2	1.934 s.—
19	-------	-------
20	-------	-------
	4	1.925
21	2	1.932 u.+
22	2	1.952 u.
23	1	1.895 u.
24	5	1.924 s.—
25	2	1.931 s.—
26	2	1.935 s.—
27	-------	-------
28	-------	-------
29	2	1.924 s.—
30	-------	-------
31	-------	-------
	5	1.932
Monthly mean..	15	1.930
Feb. 1	-------	-------
2	-------	-------
3	-------	-------
4	5	1.942 s.—
5	5	1.939 s.—
6	-------	-------
7	-------	-------
8	3	1.937 u.+
9	2	1.931 s.—
10	5	1.929 s.—
	5	1.938

Date	Number of values	S. C. and grade
1929		
Feb. 11	2	1.935 s.—
12	2	1.918 s.—
13	2	1.911 s.—
14	2	1.915 s.—
15	2	1.924 s.—
16	2	1.925 s.—
17	-------	-------
18	-------	-------
19	3	1.934 s.—
20	3	1.924 s.—
	8	1.925
21	3	1.930 s.—
22	5	1.920 s.—
23	5	1.926 s.—
24	5	1.945 u.+
25	-------	-------
26	5	1.928 s.—
27	5	1.908 u.
28	5	1.930 s.—
	6	1.932
Monthly mean..	17	1.932
Mar. 1	5	1.932 s.—
2	-------	-------
3	5	1.938 s.—
4	5	1.919 s.—
5	3	1.925 s.—
6	-------	-------
7	5	1.931 s.—
8	-------	-------
9	-------	-------
10	-------	-------
	5	1.929
11	5	1.953 u.
12	5	1.932 s.—
13	-------	-------
14	3	1.911 u.
15	5	1.882 u.
16	3	1.914 u.
17	3	1.895 u.
18	5	1.940 u.+
19	-------	-------
20	3	1.931 s.—
	3	1.934
21	-------	-------
22	-------	-------
23	2	1.911 u.
24	3	1.927 s.—
25	2	1.924 s.—
26	3	1.919 u.+
27	3	1.924 s.—
28	5	1.928 s.—
29	-------	-------
30	-------	-------
31	-------	-------
	5	1.924
Monthly mean..	13	1.929

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1929		
Apr. 1	-------	-------
2	5	1.925 u.+
3	5	1.914 u.+
4	-------	-------
5	-------	-------
6	3	1.908 u.
7	-------	-------
8	3	1.936 s.−
9	3	1.922 s.−
10	5	1.900 u.
	4	1.924
11	5	1.914 s.−
12	5	1.941 s.−
13	2	1.938 s.−
14	5	1.937 s.−
15	-------	-------
16	4	1.938 s.−
17	5	1.928 s.−
18	5	1.954 u.
19	-------	-------
20	-------	-------
	6	1.933
21	-------	-------
22	3	1.942 s.−
23	3	1.914 u.
24	5	1.940 s.−
25	-------	-------
26	-------	-------
27	-------	-------
28	4	1.924 s.−
29	5	1.946 u.+
30	-------	-------
	4	1.938
Monthly mean	14	1.932
May 1	5	1.950 u.
2	5	1.929 s.−
3	3	1.963 u.
4	3	1.935 s.−
5	5	1.947 s.−
6	5	1.933 s.−
7	5	1.945 s.−
8	3	1.950 s.−
9	5	1.943 s.−
10	3	1.956 u.
	7	1.940
11	3	1.928 u.+
12	5	1.910 u.
13	5	1.943 s.−
14	5	1.910 u.
15	5	1.940 s.−
16	-------	-------
17	3	1.928 s.−
18	-------	-------
19	5	1.918 u.+
20	-------	-------
	5	1.931
21	-------	-------
22	-------	-------

Date	Number of values	S. C. and grade
1929		
May 23	-------	-------
24	-------	-------
25	-------	-------
26	5	1.919 s.−
27	5	1.877 u.
28	3	1.900 u.
29	-------	-------
30	5	1.941 s.−
31	-------	-------
	2	1.930
Monthly mean	14	1.938
June 1	4	1.900 u.
2	4	1.911 u.
3	2	1.934 s.−
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	1	1.934
11	-------	-------
12	-------	-------
13	-------	-------
14	5	1.913 u.
15	-------	-------
16	-------	-------
17	3	1.907 u.
18	5	1.943 s.−
19	3	1.935 s.−
20	3	1.925 s.−
	3	1.934
21	5	1.914 s.−
22	5	1.932 s.−
23	3	1.925 s.−
24	3	1.913 u.
25	3	1.926 s.−
26	3	1.902 u.
27	5	1.903 u.
28	-------	-------
29	-------	-------
30	-------	-------
	4	1.924
Monthly mean	7	1.931
July 1	5	1.860 u.
2	5	1.899 u.
3	-------	-------
4	5	1.929 u.+
5	5	1.913 u.
6	-------	-------
7	-------	-------
8	-------	-------
9	3	1.895 u.
10	5	1.914 u.
	1	1.929

Date	Number of values	S. C. and grade
1929		
July 11	3	1.924 s.−
12	4	1.928 s.−
13	2	1.936 s.−
14	5	1.945 s.−
15	4	1.927 s.−
16	-------	-------
17	-------	-------
18	-------	-------
19	3	1.948 s.−
20	4	1.948 s.−
	7	1.937
21	1	1.929 u.+
22	1	1.925 u.+
23	-------	-------
24	-------	-------
25	4	1.948 u.+
26	-------	-------
27	3	1.931 s.−
28	5	1.947 u.+
29	-------	-------
30	5	1.930 s.−
31	-------	-------
	6	1.935
Monthly mean	13	1.935
Aug. 1	2	1.936 u.+
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	3	1.928 u.+
7	3	1.931 u.+
8	4	1.929 s.−
9	3	1.913 u.
10	-------	-------
	4	1.929
11	-------	-------
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	2	1.923 u.+
	1	1.923
21	-------	-------
22	-------	-------
23	-------	-------
24	5	1.942 s.−
25	5	1.929 s.−
26	1	1.929 u.+
27	-------	-------
28	-------	-------
29	-------	-------
30	2	1.928 u.
31	-------	-------
	3	1.933
Monthly mean	8	1.931

Date	Number of values	S. C. and grade
1929		
Sept. 1	-------	-------
2	5	1.915 u.
3	3	1.937 s.−
4	5	1.937 s.−
5	3	1.935 s.−
6	5	1.922 s.−
7	5	1.932 s.−
8	3	1.901 u.
9	5	1.903 u.
10	5	1.905 u.
	5	1.932
11	5	1.925 s.−
12	3	1.928 s.−
13	5	1.936 s.−
14	5	1.924 s.−
15	5	1.925 s.−
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	5	1.903 u.
	5	1.927
21	5	1.919 s.−
22	3	1.934 s.−
23	3	1.932 s.−
24	5	1.939 s.−
25	5	1.938 s.−
26	3	1.941 s.−
27	5	1.941 s.−
28	5	1.937 s.−
29	5	1.935 s.−
30	5	1.940 s.−
	10	1.936
Monthly mean	20	1.932
Oct. 1	-------	-------
2	-------	-------
3	-------	-------
4	5	1.932 s.−
5	-------	-------
6	5	1.939 s.−
7	5	1.954 u.
8	3	1.940 s.−
9	3	1.938 s.−
10	3	1.928 u.+
	5	1.934
11	3	1.935 s.−
12	5	1.938 s.−
13	5	1.946 s.−
14	5	1.948 s.−
15	-------	-------
16	3	1.915 u.
17	3	1.942 s.−
18	5	1.929 u.+
19	5	1.929 s.−
20	5	1.915 s.−
	8	1.935
21	5	1.920 s.−
22	5	1.930 s.−

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1929		
Oct. 23	4	1.931 s.−
24	5	1.901 u.
25	5	1.911 u.
26	5	1.931 s.−
27	2	1.923 s.−
28	-------	-------
29	2	1.902 u.
30	-------	-------
31	5	1.930 s.−
	6	1.926
Monthly mean..	18	1.933
[1] Nov. 1	2	1.928 s.−
2	5	1,933 s.−
3	5	1.938 s.−
4	5	1.931 s.−
5	4	1.937 s.−
6	5	1.926 s.−
7	5	1.895 u.
8	5	1.922 s.−
9	2	1.925 u.+
10	5	1.932 s.−
	9	1.937
11	-------	-------
12	2	1.920 u.+
13	2	1.925 s.−
14	2	1.931 s.−
15	5	1.929 s.−
16	2	1.929 s.−
17	5	1.925 s.−
18	5	1.923 s.−
19	2	1.932 s.−
20	5	1.923 s.−
	9	1.933
21	2	1.934 s.−
22	5	1.925 s.−
23	5	1.945 s.−
24	5	1.929 s.−
25	4	1.938 s.−
26	2	1.927 s.−
27	4	1.923 s.−
28	2	1.938 s.−
29	5	1.938 s.−
30	5	1.932 s.−
	10	1.940
Monthly mean..	28	1.937
Dec. 1	2	1.940 u.
2	2	1.931 u.+
3	-------	-------
4	3	1.945 u.+
5	2	1.944 u.+
6	5	1.935 s.−
7	5	1.937 s.−
8	4	1.952 u.
9	-------	-------
10	-------	-------
	6	1.947
11	2	1.929 s.−
12	5	1.929 s.−

Date	Number of values	S. C. and grade
1929		
Dec. 13	5	1.933 s.−
14	-------	-------
15	5	1.930 s.−
16	-------	-------
17	-------	-------
18	-------	-------
19	5	1.947 s.−
20	2	1.940 u.+
	6	1.943
21	2	1.926 u.+
22	5	1.929 s.−
23	2	1.927 s.−
24	5	1.940 s.−
25	-------	-------
26	2	1.927 s.−
27	5	1.929 s.−
28	5	1.934 s.−
29	4	1.931 s.−
30	-------	-------
31	2	1.923 s.−
	9	1.938
Monthly mean..	21	1.942
1930		
Jan. 1	5	1.938 s.−
2	5	1.934 s.−
3	5	1.928 s.−
4	-------	-------
5	-------	-------
6	-------	-------
7	5	1.921 s.−
8	2	1.903 u.
9	-------	-------
10	-------	-------
	4	1.941
11	-------	-------
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	5	1.949 s.−
17	2	1.937 s.−
18	1	1.934 u.+
19	2	1.928 s.−
20	-------	-------
	4	1.948
21	1	1.950 u.
22	3	1.939 s.−
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	1	1.934 u.+
29	-------	-------
30	2	1.937 s.−
31	3	1.924 u.+
	4	1.944
Monthly mean..	12	1.945

Date	Number of values	S. C. and grade
1930		
Feb. 1	4	1.938 s.−
2	5	1.940 s.−
3	2	1.924 s.−
4	-------	-------
5	4	1.933 s.−
6	5	1.921 s.−
7	2	1.974 u.
8	2	1.921 u.+
9	5	1.926 s.−
10	2	1.928 u.+
	8	1.939
11	5	1.921 s.−
12	2	1.921 s.−
13	5	1.944 s.−
14	5	1.926 s.−
15	2	1.929 s.−
16	5	1.939 s.−
17	2	1.916 u.
18	5	1.938 s.−
19	-------	-------
20	-------	-------
	7	1.943
21	-------	-------
22	-------	-------
23	-------	-------
24	3	1.916 u.
25	5	1.900 u.
26	-------	-------
27	-------	-------
28	3	1.914 u.
	-------	-------
Monthly mean..	15	1.940
Mar. 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	-------	-------
11	3	1.878 u.
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	3	1.916 u.
20	5	1.922 s.−
	1	1.931
21	3	1.932 s.−
22	3	1.922 s.−
23	2	1.930 u.+
24	5	1.938 s.−

Date	Number of values	S. C. and grade
1930		
Mar. 25	3	1.925 s.−
26	3	1.922 s.−
27	3	1.919 u.+
28	5	1.932 s.−
29	5	1.925 s.−
30	5	1.925 s.−
31	-------	-------
	10	1.936
Monthly mean..	11	1.936
Apr. 1	5	1.895 u.
2	3	1.929 s.−
3	5	1.916 u.
4	3	1.923 s.−
5	2	1.928 s.−
6	3	1.936 s.−
7	3	1.929 s.−
8	1	1.912 u.
9	5	1.932 s.−
10	-------	-------
	6	1.938
11	3	1.937 s.−
12	5	1.936 u.+
13	-------	-------
14	5	1.928 s.−
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	3	1.942
21	-------	-------
22	-------	-------
23	5	1.929 s.−
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
	1	1.937
Monthly mean..	10	1.938
May 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	3	1.939 s.−
7	-------	-------
8	-------	-------
9	5	1.910 u.
10	2	1.922 u.+
	2	1.938
11	-------	-------
12	5	1.921 s.−

[1] From November, 1929, to December, 1930, inclusive, the solar constant should be increased by .008 cal.

Table 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1930		
May 13	3	1.933 s.–
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	2	1.936
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	2	1.929 s.–
26	5	1.943 s.–
27	5	1.930 s.–
28	3	1.947 u.+
29	1	1.941 u.+
30	-------	-------
31	3	1.922 s.–
	5	1.943
Monthly mean	10	1.941
June 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	5	1.929 s.–
7	5	1.939 s.–
8	5	1.929 s.–
9	3	1.929 s.–
10	-------	-------
	4	1.939
11	5	1.948 s.–
12	3	1.943 s.–
13	5	1.936 s.–
14	3	1.934 s.–
15	3	1.932 s.–
16	3	1.950 u.+
17	-------	-------
18	3	1.943 u.+
19	5	1.944 u.+
20	5	1.932 s.–
	9	1.948
21	5	1.929 s.–
22	5	1.925 s.–
23	3	1.940 s.–
24	3	1.936 s.–
25	5	1.927 s.–
26	5	1.935 s.–
27	5	1.927 s.–
28	5	1.929 s.–
29	5	1.938 s.–
30	5	1.930 s.–
	10	1.940
Monthly mean	23	1.943

Date	Number of values	S. C. and grade
1930		
July 1	3	1.942 s.–
2	5	1.938 s.–
3	5	1.930 s.–
4	5	1.931 s.–
5	5	1.928 s.–
6	5	1.934 s.–
7	-------	-------
8	-------	-------
9	-------	-------
10	3	1.950 u.+
	7	1.944
11	3	1.943 u.+
12	3	1.956 s.–
13	5	1.941 s.–
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	5	1.945 s.–
19	3	1.938 s.–
20	5	1.939 s.–
	6	1.952
21	3	1.929 s.–
22	5	1.923 s.–
23	3	1.933 s.–
24	5	1.935 s.–
25	3	1.940 s.–
26	5	1.941 s.–
27	5	1.932 s.–
28	5	1.936 s.–
29	5	1.931 s.–
30	-------	-------
31	-------	-------
	9	1.941
Monthly mean	22	1.945
Aug. 1	-------	-------
2	-------	-------
3	5	1.930 s.–
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	5	1.950 s.–
10	3	1.945 s.–
	3	1.950
11	3	1.940 s.–
12	-------	-------
13	3	1.944 s.–
14	5	1.929 s.–
15	5	1.933 s.–
16	3	1.935 s.–
17	5	1.926 s.–
18	3	1.928 s.–
19	5	1.931 s.–
20	5	1.933 s.–
	9	1.941
21	5	1.925 s.–
22	5	1.913 u.

Date	Number of values	S. C. and grade
1930		
Aug. 23	-------	-------
24	-------	-------
25	-------	-------
26	3	1.922 s.–
27	5	1.934 s.–
28	3	1.930 s.–
29	5	1.930 s.–
30	5	1.939 s.–
31	5	1.930 s.–
	7	1.938
Monthly mean	19	1.942
Sept. 1	5	1.928 s.–
2	5	1.932 s.–
3	3	1.922 u.+
4	5	1.923 s.–
5	3	1.922 s.–
6	5	1.927 s.–
7	5	1.925 s.–
8	3	1.938 s.–
9	5	1.932 s.–
10	3	1.928 s.–
	10	1.935
11	3	1.926 s.–
12	5	1.932 s.–
13	5	1.934 s.–
14	5	1.919 s.–
15	3	1.922 s.–
16	5	1.929 u.+
17	3	1.925 s.–
18	5	1.930 s.–
19	-------	-------
20	-------	-------
	8	1.934
21	5	1.930 s.–
22	3	1.938 u.+
23	1	1.945 u.+
24	5	1.937 s.–
25	1	1.933 u.+
26	5	1.949 s.–
27	5	1.946 s.–
28	3	1.938 s.–
29	-------	-------
30	5	1.933 s.–
	9	1.946
Monthly mean	27	1.938
Oct. 1	5	1.957 u.
2	5	1.928 s.–
3	5	1.933 s.–
4	5	1.921 s.–
5	5	1.918 s.–
6	5	1.927 s.–
7	1	1.902 u.
8	5	1.946 s.–
9	-------	-------
10	1	1.925 s.–
	7	1.935

Date	Number of values	S. C. and grade
1930		
Oct. 11	3	1.923 s.–
12	5	1.928 s.–
13	3	1.918 s.–
14	5	1.928 s.–
15	3	1.926 s.–
16	3	1.924 s.–
17	4	1.926 s.–
18	5	1.926 s.–
19	2	1.923 u.+
20	5	1.933 s.–
	10	1.933
21	3	1.931 u.+
22	5	1.922 s.–
23	5	1.926 s.–
24	3	1.926 s.–
25	4	1.921 s.–
26	5	1.924 s.–
27	5	1.929 s.–
28	5	1.930 s.–
29	5	1.934 s.–
30	5	1.918 s.–
31	5	1.922 s.–
	11	1.933
Monthly mean	28	1.933
Nov. 1	5	1.931 s.–
2	5	1.932 s.–
3	2	1.925 s.–
4	2	1.926 s.–
5	5	1.929 s.–
6	2	1.941 s.–
7	3	1.924 s.–
8	2	1.931 u.+
9	-------	-------
10	5	1.920 s.–
	9	1.936
11	2	1.924 s.–
12	5	1.935 s.–
13	-------	-------
14	2	1.925 s.–
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	2	1.917 s.–
20	2	1.917 s.–
	5	1.929
21	2	1.916 s.–
22	-------	-------
23	5	1.920 s.–
24	5	1.917 s.–
25	2	1.922 s.–
26	-------	-------
27	-------	-------
28	-------	-------
29	5	1.920 s.–
30	3	1.919 s.–
	6	1.926
Monthly mean	20	1.931

TABLE 32.—*Solar-constant values. Short method. Table Mountain, 1925–1930*—Continued

Date	Number of values	S. C. and grade
1930		
Dec. 1	-------	-------
2	2	1.924 s.−
3	2	1.926 s.−
4	-------	-------
5	5	1.919 s.−
6	4	1.929 s.−
7	2	1.918 s.−
8	5	1.930 s.−
9	5	1.937 s.−
10	5	1.931 s.−
	8	1.935

Date	Number of values	S. C. and grade
1930		
Dec. 11	2	1.929 s.−
12	5	1.925 s.−
13	-------	-------
14	5	1.940 s.−
15	4	1.921 s.−
16	-------	-------
17	2	1.926 s.−
18	1	1.921 u.+
19	5	1.925 s.−
20	4	1.919 s.−
	8	1.934

Date	Number of values	S. C. and grade
1930		
Dec. 21	-------	-------
22	2	1.914 u.
23	-------	-------
24	-------	-------
25	-------	-------
26	5	1.920 s.−
27	2	1.921 s.−
28	4	1.929 s.−
29	5	1.921 s.−

Date	Number of values	S. C. and grade
1930		
Dec. 30	5	1.925 s.−
31	5	1.927 s.−
	6	1.934
Monthly mean	22	1.934

TABLE 33.—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*[1]

Date	Number of values	S. C. and grade
1926		
Dec. 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	4	1.952 s.
	1	1.952
11	-------	-------
12	1	1.943 u.
13	-------	-------
14	4	1.936 s.−
15	-------	-------
16	-------	-------
17	-------	-------
18	4	1.947 s.−
19	3	1.949 s.−
20	-------	-------
	3	1.944
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	-------	-------
29	3	1.938 s.
30	2	1.950 u.+
31	2	1.935 s.−
	3	1.941
Monthly mean	7	1.944
1927		
Jan. 1	2	1.932 s.−
2	-------	-------
3	-------	-------
4	5	1.953 s.−

Date	Number of values	S. C. and grade
1927		
Jan. 5	4	1.960 u.+
6	3	1.944 s.−
7	4	1.981 u.
8	4	1.958 s.−
9	-------	-------
10	5	1.930 s.−
	6	1.946
11	4	1.938 s.−
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	1	1.938
21	1	1.916 u.
22	1	1.944 u.
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
31	-------	-------
	-------	-------
Monthly mean	7	1.945
Feb. 1	5	1.947 s.−
2	5	1.949 s.−
3	-------	-------
4	-------	-------
5	5	1.949 s.−
6	3	1.948 s.−
7	4	1.961 s.−
8	5	1.933 u.+

Date	Number of values	S. C. and grade
1927		
Feb. 9	-------	-------
10	-------	-------
	6	1.948
11	-------	-------
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	5	1.933 s.−
18	4	1.931 s.−
19	5	1.933 s.−
20	5	1.945 s.−
	4	1.936
21	5	1.942 s.−
22	-------	-------
23	5	1.930 u.+
24	4	1.928 u.+
25	-------	-------
26	5	1.945 s.−
27	5	1.933 s.−
28	5	1.938 s.−
	6	1.936
Monthly mean	16	1.940
Mar. 1	5	1.944 s.−
2	5	1.935 s.−
3	-------	-------
4	5	1.931 s.−
5	1	1.929 s.−
6	-------	-------
7	4	1.912 u.
8	4	1.929 u.+
9	-------	-------
10	5	1.933 u.+
	6	1.934
11	5	1.951 s.−
12	5	1.936 s.−

Date	Number of values	S. C. and grade
1927		
Mar. 13	4	1.939 s.−
14	4	1.934 s.−
15	5	1.939 s.−
16	-------	-------
17	5	1.950 s.−
18	-------	-------
19	-------	-------
20	-------	-------
	6	1.942
21	5	1.952 s.−
22	4	1.948 s.−
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	-------	-------
29	5	1.952 s.−
30	-------	-------
31	4	1.947 s.−
	4	1.950
Monthly mean	16	1.941
Apr. 1	4	1.962 s.−
2	4	1.943 s.−
3	5	1.946 s.−
4	4	1.963 s.−
5	-------	-------
6	-------	-------
7	5	1.936 s.−
8	5	1.945 s.−
9	-------	-------
10	-------	-------
	6	1.950
11	-------	-------
12	-------	-------
13	1	1.923 u.
14	-------	-------
15	5	1.954 u.+
16	5	1.970 u.

[1] This station was founded and supported by the National Geographic Society 1926 to 1929, and thereafter supported by Mr. J. A. Roebling.

TABLE 33—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*—Continued

Date	Number of values	S. C. and grade
1927		
Apr. 17	3	1.959 s.–
18	------	------
19	3	1.931 s.–
20	------	------
	3	1.948
21	------	------
22	5	1.945 s.–
23	4	1.955 s.–
24	5	1.930 s.–
25	5	1.948 s.–
26	4	1.920 u.+
27	4	1.931 s.–
28	3	1.931 s.–
29	4	1.940 s.–
30	5	1.932 s.–
	9	1.937
Monthly mean	18	1.944
May 1	------	------
2	------	------
3	5	1.913 u.
4	5	1.913 u.
5	------	------
6	4	1.937 s.–
7	4	1.951 s.–
8	4	1.947 s.–
9	------	------
10	4	1.916 u.+
	4	1.938
11	3	1.943 s.–
12	4	1.940 s.–
13	1	1.930 s.–
14	5	1.955 s.–
15	4	1.948 s.–
16	4	1.939 s.–
17	3	1.935 s.–
18	4	1.936 s.–
19	4	1.938 s.–
20	4	1.923 u.+
	10	1.939
21	3	1.889 u.
22	4	1.945 u.+
23	------	------
24	------	------
25	------	------
26	5	1.904 u.
27	4	1.843 u.
28	------	------
29	------	------
30	4	1.854 u.
31	4	1.865 u.
	1	1.945
Monthly mean	15	1.939
June 1	4	1.833 u.
2	5	1.892 u.
3	------	------
4	------	------

Date	Number of values	S. C. and grade
1927		
June 5	4	1.947 s.–
6	4	1.953 s.–
7	4	1.925 u.+
8	------	------
9	5	1.890 u.
10	5	1.886 u.
	3	1.941
11	4	1.910 u.
12	5	1.923 u.+
13	------	------
14	5	1.931 s.–
15	------	------
16	2	1.926 s.–
17	4	1.894 u.
18	4	1.896 u.
19	4	1.910 u.
20	5	1.934 s.–
	4	1.928
21	4	1.938 s.–
22	------	------
23	------	------
24	------	------
25	4	1.862 u.
26	------	------
27	------	------
28	------	------
29	------	------
30	------	------
	1	1.938
Monthly mean	8	1.934
July 1	5	1.947 s.–
2	5	1.931 s.–
3	5	1.927 s.–
4	4	1.940 s.–
5	4	1.845 u.
6	5	1.947 s.–
7	4	1.910 u.
8	4	1.748 u.
9	1	1.597 u.
10	4	1.787 u.
	5	1.938
11	4	1.881 u.
12	------	------
13	4	1.941 s.–
14	4	1.960 s.–
15	4	1.955 s.–
16	4	1.950 s.–
17	4	1.946 s.–
18	------	------
19	------	------
20	5	1.802 u.
	5	1.950
21	5	1.896 u.
22	4	1.984 u.
23	4	1.949 s.–
24	------	------
25	4	1.951 s.–
26	4	1.942 s.–

Date	Number of values	S. C. and grade
1927		
July 27	4	1.937 s.–
28	4	1.917 u.
29	5	1.918 u.
30	5	1.852 u.
31	------	------
	4	1.945
Monthly mean	14	1.944
Aug. 1	4	1.880 u.
2	------	------
3	------	------
4	------	------
5	4	1.894 u.
6	4	1.934 s.–
7	4	1.948 s.–
8	4	1.947 s.–
9	------	------
10	------	------
	3	1.943
11	------	------
12	------	------
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	2	1.771 u.
19	------	------
20	------	------
	------	------
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	5	1.959 s.–
27	------	------
28	4	1.937 s.–
29	4	1.942 s.–
30	4	1.935 s.–
31	4	1.954 s.–
	5	1.945
Monthly mean	8	1.944
Sept. 1	4	1.957 s.–
2	5	1.936 s.–
3	5	1.887 u.
4	------	------
5	------	------
6	------	------
7	------	------
8	4	1.903 u.
9	------	------
10	------	------
	2	1.946
11	------	------
12	------	------
13	------	------

Date	Number of values	S. C. and grade
1927		
Sept. 14	------	------
15	------	------
16	3	1.935 s.–
17	4	1.954 s.–
18	5	1.935 s.–
19	5	1.917 u.
20	------	------
	3	1.941
21	------	------
22	4	1.906 u.
23	------	------
24	------	------
25	4	1.930 s.–
26	4	1.903 u.
27	------	------
28	------	------
29	------	------
30	------	------
	1	1.930
Monthly mean	6	1.941
Oct. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	5	1.945 s.–
8	4	1.936 s.–
9	------	------
10	------	------
	2	1.940
11	------	------
12	------	------
13	------	------
14	4	1.952 s.–
15	5	1.984 u.
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	1	1.952
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	5	1.940 s.–
30	------	------
31	5	1.958 s.–
	2	1.949
Monthly mean	5	1.946

TABLE 33.—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*—Continued

Date	Number of values	S. C. and grade
1927		
Nov. 1	5	1.945 s.−
2	4	1.944 s.−
3	4	1.949 s.−
4	4	1.935 s.−
5	-------	-------
6	5	1.917 u.
7	-------	-------
8	-------	-------
9	-------	-------
10	4	1.950 s.−
	5	1.945
11	5	1.935 s.−
12	4	1.946 s.−
13	4	1.970 s.−
14	-------	-------
15	4	1.938 s.−
16	5	1.946 s.−
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	5	1.947
21	-------	-------
22	-------	-------
23	-------	-------
24	5	1.950 s.−
25	-------	-------
26	-------	-------
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
	1	1.950
Monthly mean	11	1.946
Dec. 1	5	1.952 s.−
2	-------	-------
3	5	1.932 s.−
4	5	1.929 s.−
5	5	1.943 s.−
6	-------	-------
7	-------	-------
8	4	1.946 s.−
9	2	1.950 s.−
10	5	1.944 s.−
	7	1.942
11	4	1.950 s.−
12	-------	-------
13	4	1.948 s.−
14	5	1.945 s.−
15	5	1.940 s.−
16	-------	-------
17	-------	-------
18	-------	-------
19	5	1.939 s.−
20	-------	-------
	5	1.944
21	-------	-------
22	-------	-------

Date	Number of values	S. C. and grade
1927		
Dec. 23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	5	1.943 s.−
28	5	1.942 s.−
29	5	1.930 s.−
30	4	1.946 s.−
31	-------	-------
	4	1.940
Monthly mean	16	1.942
1928		
Jan. 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	5	1.939 s.−
6	4	1.938 s.−
7	5	1.943 s.−
8	-------	-------
9	5	1.936 s.−
10	5	1.924 u.+
	5	1.936
11	5	1.925 u.+
12	-------	-------
13	5	1.937 u.
14	-------	-------
15	2	1.896 u.
16	5	1.936 s.−
17	4	1.937 s.−
18	4	1.925 u.+
19	-------	-------
20	-------	-------
	4	1.931
21	-------	-------
22	4	1.940 s.−
23	5	1.911 u.
24	5	1.928 u.+
25	-------	-------
26	5	1.932 s.−
27	5	1.936 s.−
28	4	1.942 s.−
29	5	1.932 s.−
30	4	1.946 s.−
31	5	1.915 u.
	7	1.937
Monthly Mean	16	1.935
Feb. 1	-------	-------
2	-------	-------
3	-------	-------
4	5	1.931 s.−
5	-------	-------
6	1	1.946 u.
7	5	1.926 u.+
8	5	1.943 s.−
9	5	1.940 s.−
10	-------	-------
	4	1.935

Date	Number of values	S. C. and grade
1958		
Feb. 11	-------	-------
12	5	1.956 s.−
13	2	1.923 u.
14	5	1.938 s.−
15	4	1.906 u.
16	5	1.937 s.−
17	-------	-------
18	5	1.950 s.−
19	5	1.936 s.−
20	5	1.937 s.−
	6	1.942
21	-------	-------
22	5	1.949 s.−
23	5	1.927 u.+
24	5	1.951 s.−
25	1	1.927 u.
26	5	1.938 s.−
27	5	1.954 s.−
28	-------	-------
29	-------	-------
	5	1.944
Monthly Mean	15	1.941
Mar. 1	-------	-------
2	-------	-------
3	5	1.946 s.−
4	2	1.933 s.−
5	-------	-------
6	1	1.924 u.
7	5	1.936 s.−
8	-------	-------
9	-------	-------
10	5	1.922 u.
	3	1.938
11	5	1.924 u.
12	-------	-------
13	4	1.933 u.+
14	-------	-------
15	-------	-------
16	-------	-------
17	5	1.940 s.−
18	5	1.937 s.−
19	5	1.915 u.
20	5	1.938 s.−
	4	1.937
21	-------	-------
22	5	1.922 u.+
23	-------	-------
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	4	1.936 s.−
29	5	1.961 u.+
30	4	1.966 u.+
31	4	1.936 u.+
	5	1.944
Monthly Mean	12	1.940

Date	Number of values	S. C. and grade
1928		
Apr. 1	5	1.942 s.−
2	4	1.942 s.−
3	5	1.924 u.+
4	5	1.935 s.−
5	-------	-------
6	5	1.955 s.−
7	1	1.972 u.
8	-------	-------
9	5	1.944 s.−
10	4	1.944 s.−
	7	1.941
11	4	1.940 s.−
12	-------	-------
13	-------	-------
14	-------	-------
15	4	1.940 s.−
16	5	1.932 s.−
17	5	1.937 s.−
18	-------	-------
19	5	1.931 s.−
20	5	1.930 s.−
	6	1.935
21	5	1.954 s.−
22	-------	-------
23	5	1.936 s.−
24	5	1.944 s.−
25	4	1.939 s.−
26	4	1.945 s.−
27	4	1.931 s.−
28	4	1.942 s.−
29	5	1.937 s.−
30	-------	-------
	8	1.941
Monthly Mean	21	1.939
May 1	5	1.923 u.+
2	5	1.946 s.−
3	-------	-------
4	-------	-------
5	5	1.932 s.−
6	5	1.947 s.−
7	4	1.941 s.−
8	4	1.951 s.−
9	4	1.930 u.+
10	-------	-------
	7	1.939
11	2	1.955 u.
12	5	1.965 u.+
13	5	1.949 s.−
14	5	1.943 s.−
15	5	1.937 s.−
16	4	1.926 u.+
17	2	1.944 u.
18	5	1.922 u.
19	2	1.915 u.
20	4	1.936 u.+
	6	1.943
21	-------	-------
22	4	1.930 s.−

TABLE 33.—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*—Continued

Date	Number of values	S. C. and grade
1928		
May 23	5	1.929 s.−
24	5	1.928 s.−
25	5	1.933 s.−
26	4	1.935 s.−
27	4	1.934 s.−
28	4	1.929 s.−
29	5	1.905 u.
30	1	1.900 u.
31	5	1.958 u.+
	8	1.935
Monthly mean	21	1.939
June 1	5	1.955 s.−
2	3	1.945 s.−
3	5	1.922 u.+
4	5	1.932 u.+
5	5	1.921 u.+
6	5	1.892 u.
7	5	1.911 u.
8	------	------
9	5	1.918 u.
10	5	1.977 u.
	5	1.935
11	5	1.961 u.
12	4	1.952 u.+
13	4	1.971 u.
14	5	1.963 u.
15	5	1.957 s.−
16	4	1.935 s.−
17	5	1.946 s.−
18	4	1.944 s.−
19	5	1.940 s.−
20	4	1.901 u.
	6	1.946
21	5	1.965 u.
22	5	1.941 s.−
23	5	1.935 s.−
24	5	1.949 s.−
25	2	1.992 u.
26	5	1.941 s.−
27	5	1.949 s.−
28	4	1.960 u.+
29	5	1.969 u.
30	1	1.978 u.
	6	1.946
Monthly mean	17	1.943
July 1	2	1.934 u.+
2	------	------
3	------	------
4	------	------
5	5	1.972 u.
6	5	1.961 u.+
7	5	1.954 s.−
8	------	------
9	5	1.957 s.−
10	------	------
	4	1.952

Date	Number of values	S. C. and grade
1928		
July 11	4	1.882 u.
12	------	------
13	------	------
14	2	1.968 u.
15	3	1.936 u.+
16	5	1.855 u.
17	------	------
18	5	1.928 u.+
19	4	1.851 u.
20	------	------
	2	1.932
21	4	1.790 u.
22	5	1.946 s.−
23	4	1.855 u.
24	------	------
25	5	1.942 s.−
26	5	1.944 s.−
27	------	------
28	------	------
29	4	1.952 s.−
30	4	1.944 s.−
31	------	------
	5	1.946
Monthly mean	11	1.946
Aug. 1	------	------
2	------	------
3	------	------
4	------	------
5	2	1.786 u.
6	5	1.957 s.−
7	4	1.943 s.−
8	4	1.963 s.−
9	4	1.957 s.−
10	5	1.959 s.−
	5	1.956
11	5	1.927 u.
12	------	------
13	5	1.951 u.+
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	5	1.960 u.+
20	4	1.955 u.+
	3	1.955
21	2	1.951 u.+
22	4	1.932 u.+
23	------	------
24	------	------
25	5	1.866 u.
26	------	------
27	------	------
28	------	------
29	5	1.898 u.
30	4	1.920 u.+
31	------	------
	3	1.934
Monthly mean	11	1.950

Date	Number of values	S. C. and grade
1928		
Sept. 1	5	1.940 s.−
2	5	1.937 s.−
3	------	------
4	------	------
5	------	------
6	5	1.954 s.−
7	5	1.941 s.−
8	5	1.929 s.−
9	5	1.947 s.−
10	4	1.841 u.
	6	1.941
11	------	------
12	------	------
13	4	1.938 s.−
14	------	------
15	5	1.957 s.−
16	5	1.907 u.
17	4	1.960 s.−
18	5	1.933 u.+
19	5	1.909 u.
20	------	------
	4	1.947
21	3	1.951 u.+
22	------	------
23	------	------
24	5	1.932 u.+
25	------	------
26	------	------
27	------	------
28	5	1.944 u.+
29	------	------
30	------	------
	3	1.942
Monthly mean	13	1.943
Oct. 1	4	1.941 s.−
2	4	1.919 u.+
3	5	1.950 s.−
4	4	1.952 s.−
5	5	1.941 s.−
6	5	1.944 s.−
7	5	1.911 u.
8	------	------
9	------	------
10	------	------
	6	1.941
11	5	1.930 u.+
12	------	------
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	------	------
20	5	1.981 u.
	1	1.930
21	------	------
22	5	1.952 s.−

Date	Number of values	S. C. and grade
1928		
Oct. 23	1	1.950 u.
24	4	1.944 s.−
25	5	1.927 s.−
26	4	1.930 s.−
27	4	1.942 s.−
28	5	1.948 s.−
29	5	1.956 s.−
30	4	1.947 s.−
31	------	------
	8	1.943
Monthly mean	15	1.941
Nov. 1	------	------
2	------	------
3	------	------
4	5	1.946 s.−
5	------	------
6	------	------
7	4	1.947 s.−
8	5	1.953 s.−
9	5	1.955 s.−
10	------	------
	4	1.950
11	5	1.954 s.−
12	5	1.956 s.−
13	4	1.961 s.−
14	------	------
15	------	------
16	4	1.979 u.
17	------	------
18	------	------
19	------	------
20	------	------
	3	1.957
21	------	------
22	------	------
23	------	------
24	------	------
25	------	------
26	------	------
27	------	------
28	------	------
29	5	1.948 u.+
30	------	------
	1	1.948
Monthly mean	8	1.952
Dec. 1	------	------
2	------	------
3	------	------
4	------	------
5	5	1.955 s.−
6	5	1.960 s.−
7	4	1.933 s.−
8	5	1.963 u.
9	5	1.945 u.+
10	------	------
	4	1.948

TABLE 33.—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*—Continued

Date	Number of values	S. C. and grade
1928		
Dec. 11	------	------
12	------	------
13	5	1.947 s.−
14	------	------
15	------	------
16	------	------
17	4	1.936 s.−
18	------	------
19	------	------
20	------	------
	2	1.942
21	------	------
22	------	------
23	------	------
24	------	------
25	5	1.932 s.−
26	4	1.943 s.−
27	------	------
28	------	------
29	------	------
30	3	1.953 s.−
31	5	1.957 s.−
	4	1.946
Monthly mean	10	1.946
1929		
Jan. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	------	------
8	------	------
9	------	------
10	------	------
	------	------
11	------	------
12	------	------
13	------	------
14	------	------
15	------	------
16	------	------
17	------	------
18	------	------
19	------	------
20	------	------
	------	------
21	5	1.939 s.−
22	------	------
23	------	------
24	5	1.949 s.−
25	------	------
26	5	1.930 s.−
27	4	1.934 s.−
28	------	------
29	4	1.930 s.−
30	------	------
31	------	------
	5	1.936
Monthly mean	5	1.936

Date	Number of values	S. C. and grade
1929		
Feb. 1	------	------
2	------	------
3	------	------
4	------	------
5	------	------
6	------	------
7	5	1.941 s.−
8	------	------
9	------	------
10	------	------
	1	1.941
11	------	------
12	------	------
13	------	------
14	------	------
15	------	------
16	4	1.952 s.−
17	2	1.937 s.−
18	4	1.956 s.−
19	5	1.956 s.−
20	5	1.959 s.−
	5	1.952
21	4	1.937 s.−
22	4	1.931 s.−
23	2	1.935 s.−
24	------	------
25	------	------
26	5	1.938 s.−
27	2	1.934 s.−
28	------	------
	5	1.935
Monthly mean	11	1.943
Mar. 1	5	1.949 s.−
2	5	1.931 u.+
3	5	1.927 u.+
4	------	------
5	------	------
6	5	1.932 s.−
7	5	1.934 s.−
8	------	------
9	------	------
10	2	1.907 u.
	5	1.935
11	5	1.941 s.−
12	5	1.926 u.+
13	5	1.925 u.+
14	5	1.934 u.+
15	5	1.939 s.−
16	4	1.935 s.−
17	5	1.933 s.−
18	4	1.927 s.−
19	5	1.935 s.−
20	------	------
	9	1.933
21	5	1.946 s.−
22	5	1.947 s.−
23	------	------
24	------	------

Date	Number of values	S. C. and grade
1929		
Mar. 25	------	------
26	------	------
27	5	1.930 u.+
28	------	------
29	5	1.931 u.+
30	------	------
31	------	------
	4	1.938
Monthly mean	18	1.935
Apr. 1	4	1.930 u.+
2	------	------
3	------	------
4	5	1.936 s.−
5	5	1.940 s.−
6	5	1.925 s.−
7	5	1.930 s.−
8	4	1.920 s.−
9	5	1.933 s.−
10	------	------
	7	1.931
11	5	1.924 u.+
12	------	------
13	5	1.931 u.+
14	4	1.915 u.
15	5	1.934 u.+
16	------	------
17	------	------
18	5	1.925 u.+
19	5	1.932 u.+
20	4	1.926 u.+
	6	1.929
21	5	1.926 u.+
22	------	------
23	5	1.928 s.−
24	------	------
25	5	1.932 s.−
26	4	1.942 s.−
27	------	------
28	1	1.928 s.−
29	4	1.946 s.−
30	4	1.938 s.−
	7	1.934
Monthly mean	20	1.931
May 1	------	------
2	------	------
3	------	------
4	------	------
5	5	1.934 s.−
6	------	------
7	4	1.936 s.
8	4	1.912 u.
9	5	1.927 u.+
10	5	1.922 u.+
	4	1.930
11	------	------
12	4	1.944 s.−

Date	Number of values	S. C. and grade
1929		
May 13	5	1.928 s.−
14	5	1.926 s.−
15	4	1.933 s.−
16	5	1.929 s.−
17	4	1.924 s.−
18	5	1.921 s.−
19	------	------
20	------	------
	7	1.929
21	5	1.906 u.
22	4	1.932 u.+
23	4	1.918 u.+
24	4	1.931 s.−
25	------	------
26	5	1.934 s.−
27	4	1.936 s.−
28	------	------
29	4	1.905 u.
30	------	------
31	------	------
	5	1.930
Monthly mean	16	1.930
June 1	------	------
2	5	1.898 u.
3	------	------
4	5	1.930 s.−
5	5	1.932 s.−
6	5	1.946 s.−
7	5	1.933 s.−
8	5	1.923 s.−
9	5	1.934 s.−
10	5	1.921 s.−
	7	1.931
11	5	1.935 u.+
12	4	1.844 u.
13	5	1.861 u.
14	4	1.914 u.+
15	5	1.920 u.+
16	5	1.926 u.+
17	------	------
18	------	------
19	------	------
20	------	------
	4	1.924
21	------	------
22	5	1.905 u.
23	------	------
24	5	1.932 s.−
25	5	1.945 s.−
26	4	1.940 s.−
27	4	1.942 s.−
28	4	1.896 u.
29	1	1.556 u.
30	------	------
	4	1.940
Monthly mean	15	1.932

TABLE 33.—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*—Continued

Date	Number of values	S. C. and grade
1929		
July 1	5	1.948 s.−
2	4	1.937 s.−
3	-------	-------
4	5	1.929 s.−
5	5	1.922 s.−
6	4	1.921 s.−
7	5	1.891 u.
8	5	1.926 s.−
9	4	1.935 s.−
10	3	1.936 s.−
	8	1.932
11	4	1.925 u.+
12	5	1.919 u.+
13	-------	-------
14	-------	-------
15	4	1.932 u.+
16	-------	-------
17	2	1.618 u.
18	5	1.844 u.
19	5	1.900 u.
20	5	1.933 u.+
	4	1.927
21	5	1.935 u.+
22	-------	-------
23	1	1.855 u.
24	5	1.921 u.+
25	5	1.894 u.
26	5	1.936 s.−
27	5	1.903 u.
28	4	1.876 u.
29	3	1.950 s.−
30	4	1.923 s.−
31	2	1.660 u.
	5	1.933
Monthly mean	17	1.931
Aug. 1	-------	-------
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	-------	-------
11	5	1.817 u.
12	-------	-------
13	-------	-------
14	3	1.962 u.
15	5	1.947 u.+
16	-------	-------
17	5	1.931 s.−
18	5	1.922 s.−
19	5	1.923 s.−
20	3	1.946 s.−
	5	1.934

Date	Number of values	S. C. and grade
1929		
Aug. 21	-------	-------
22	-------	-------
23	5	1.940 s.−
24	5	1.946 s.−
25	5	1.929 s.−
26	4	1.927 s.−
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
31	5	1.811 u.
	4	1.936
Monthly mean	9	1.935
Sept. 1	5	1.928 u.+
2	-------	-------
3	-------	-------
4	-------	-------
5	3	1.842 u.
6	-------	-------
7	-------	-------
8	5	1.793 u.
9	5	1.934 u.+
10	-------	-------
	2	1.931
11	5	1.924 s.−
12	5	1.930 s.−
13	5	1.929 s.−
14	5	1.928 s.−
15	5	1.914 u.
16	-------	-------
17	-------	-------
18	2	1.744 u.
19	-------	-------
20	-------	-------
	4	1.928
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	5	1.896 u.
26	2	1.808 u.
27	-------	-------
28	-------	-------
29	3	1.798 u.
30	-------	-------
	-------	-------
Monthly mean	6	1.929
Oct. 1	5	1.941 s.−
2	5	1.952 s.−
3	-------	-------
4	5	1.942 s.−
5	5	1.940 s.−
6	5	1.904 u.
7	5	1.839 u.
8	-------	-------
9	-------	-------
10	4	1.937 u.+
	5	1.942

Date	Number of values	S. C. and grade
1929		
Oct. 11	2	1.916 u.
12	5	1.864 u.
13	-------	-------
14	-------	-------
15	-------	-------
16	5	1.855 u.
17	-------	-------
18	4	1.872 u.
19	-------	-------
20	-------	-------
	-------	-------
21	2	1.828 u.
22	-------	-------
23	-------	-------
24	5	1.896 u.
25	5	1.897 u.
26	4	1.931 u.+
27	5	1.915 u.+
28	4	1.917 u.+
29	5	1.931 s.−
30	5	1.937 s.−
31	-------	-------
	5	1.926
Monthly Mean	10	1.934
Nov. 1	1	1.937 s.−
2	3	1.926 s.−
3	-------	-------
4	-------	-------
5	5	1.923 s.−
6	2	1.943 s.−
7	5	1.941 s.−
8	-------	-------
9	5	1.881 u.
10	5	1.946 s.−
	6	1.936
11	4	1.959 s.−
12	-------	-------
13	5	1.960 s.−
14	-------	-------
15	-------	-------
16	-------	-------
17	5	1.949 s.−
18	-------	-------
19	5	1.937 s.−
20	4	1.943 s.−
	5	1.950
21	4	1.948 s.−
22	-------	-------
23	-------	-------
24	5	1.938 s.−
25	1	1.936 s.−
26	-------	-------
27	5	1.944 s.−
28	5	1.944 s.−
29	-------	-------
30	5	1.932 s.−
	6	1.940
Monthly mean	17	1.942

Date	Number of values	S. C. and grade
1929		
Dec. 1	5	1.947 s.−
2	5	1.945 s.−
3	5	1.945 s.−
4	4	1.957 s.−
5	5	1.593 s.−
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	5	1.946
11	5	1.951 s.−
12	4	1.952 s.−
13	-------	-------
14	-------	-------
15	-------	-------
16	2	1.948 s.−
17	-------	-------
18	-------	-------
19	5	1.948 s.−
20	4	1.955 s.−
	5	1.951
21	5	1.944 s.−
22	5	1.939 s.−
23	-------	-------
24	-------	-------
25	-------	-------
26	5	1.943 s.−
27	-------	-------
28	-------	-------
29	-------	-------
30	5	1.951 s.−
31	5	1.944 s.−
	5	1.944
Monthly mean	15	1.947
1930		
Jan. 1	5	1.950 s.−
2	-------	-------
3	-------	-------
4	-------	-------
5	-------	-------
6	5	1.950 s.−
7	5	1.947 s.−
8	5	1.943 s.−
9	4	1.953 s.−
10	5	1.945 s.−
	6	1.948
11	-------	-------
12	5	1.943 s.−
13	-------	-------
14	5	1.942 s.−
15	5	1.959 s.−
16	5	1.950 s.−
17	5	1.957 s.−
18	4	1.941 s.−
19	5	1.946 s.−
20	5	1.949 s.−
	8	1.948

Table 33.—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*—Continued

Date	Number of values	S. C. and grade
1930		
Jan. 21	5	1.945 s.−
22	-------	-------
23	3	1.947 u.+
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	5	1.939 s.−
29	5	1.956 s.−
30	2	1.944 u.+
31	-------	-------
	4	1.946
Monthly mean	18	1.948
Feb. 1	-------	-------
2	5	1.964 u.
3	4	1.959 u.+
4	4	1.972 u.
5	5	1.975 u.
6	-------	-------
7	-------	-------
8	4	1.938 u.+
9	4	1.949 u.+
10	-------	-------
	3	1.949
11	5	1.943 s.−
12	-------	-------
13	-------	-------
14	4	1.947 s.−
15	5	1.950 s.−
16	5	1.929 u.+
17	-------	-------
18	-------	-------
19	5	1.938 s.−
20	5	1.948 s.−
	6	1.943
21	4	1.951 s.−
22	-------	-------
23	-------	-------
24	-------	-------
25	5	1.946 s.−
26	5	1.958 s.−
27	5	1.953 s.−
28	5	1.953 s.−
29	-------	-------
	5	1.952
Monthly mean	14	1.947
Mar. 1	5	1.969 u.
2	-------	-------
3	5	1.953 u.+
4	-------	-------
5	1	1.961 u.
6	-------	-------
7	-------	-------
8	-------	-------
9	5	1.941 s.−
10	5	1.945 s.−
	3	1.946
1930		
Mar. 11	4	1.939 s.−
12	4	1.947 s.−
13	5	1.939 s.−
14	5	1.935 s.−
15	-------	-------
16	-------	-------
17	3	1.946 s.−
18	5	1.925 u.+
19	5	1.880 u.
20	-------	-------
	6	1.938
21	5	1.920 u.+
22	5	1.928 u.+
23	5	1.935 u.+
24	4	1.937 u.+
25	5	1.940 s.−
26	5	1.943 s.−
27	4	1.954 s.−
28	4	1.950 s.−
29	4	1.945 s.−
30	5	1.944 s.−
31	5	1.969 u.
	10	1.940
Monthly mean	19	1.940
Apr. 1	5	1.951 s.−
2	3	1.958 s.−
3	-------	-------
4	4	1.954 s.−
5	5	1.944 s.−
6	5	1.954 s.−
7	4	1.943 s.−
8	4	1.953 s.−
9	4	1.955 s.−
10	4	1.951 s.−
	9	1.951
11	4	1.956 s.−
12	5	1.953 s.−
13	5	1.952 s.−
14	-------	-------
15	5	1.952 s.−
16	5	1.944 s.−
17	4	1.934 s.−
18	4	1.931 s.−
19	5	1.932 s.−
20	4	1.942 s.−
	9	1.944
21	5	1.954 s.−
22	5	1.955 s.−
23	5	1.961 u.
24	5	1.951 s.−
25	-------	-------
26	5	1.955 s.−
27	5	1.940 s.−
28	5	1.943 s.−
29	5	1.944 s.−
30	4	1.935 s.−
	8	1.947
Monthly mean	26	1.947
1930		
May 1	5	1.943 s.−
2	5	1.946 s.−
3	5	1.952 s.−
4	5	1.946 s.−
5	5	1.953 s.−
6	5	1.944 s.−
7	4	1.954 s.−
8	5	1.947 s.−
9	5	1.958 s.−
10	1	1.928 u.
	9	1.949
11	-------	-------
12	5	1.949 s.−
13	5	1.948 s.−
14	5	1.967 u.
15	5	1.942 s.−
16	5	1.959 s.−
17	5	1.955 s.−
18	5	1.928 u.+
19	5	1.943 u.+
20	5	1.957 s.−
	8	1.948
21	5	1.937 s.−
22	5	1.953 u.+
23	4	1.964 u.
24	5	1.960 u.
25	5	1.941 s.−
26	5	1.946 s.−
27	-------	-------
28	5	1.963 u.
29	1	2.006 u.
30	5	1.958 s.−
31	4	1.955 s.−
	6	1.948
Monthly mean	23	1.948
June 1	5	1.952 s.−
2	4	1.950 s.−
3	5	1.935 s.−
4	-------	-------
5	5	1.960 u.
6	5	1.943 s.−
7	3	1.954 s.−
8	5	1.935 s.−
9	3	1.930 s.−
10	3	1.932 s.−
	8	1.941
11	5	1.902 u.
12	4	1.906 u.
13	3	1.960 u.
14	5	1.949 u.+
15	5	1.952 u.+
16	5	1.960 u.
17	5	1.940 s.−
18	3	1.937 s.−
19	5	1.926 u.+
20	3	1.917 u.
	5	1.941
21	-------	------- u.
22	5	1.864
1930		
June 23	5	1.859 u.
24	-------	-------
25	4	1.915 u.
26	5	1.915 u.
27	5	1.877 u.
28	5	1.861 u.
29	5	1.849 u.
30	5	1.942 u.+
	1	1.942
Monthly mean	14	1.941
July 1	5	1.939 s.−
2	5	1.936 s.−
3	2	1.924 u.+
4	3	1.934 u.+
5	5	1.937 s.−
6	5	1.935 s.−
7	5	1.894 u.
8	5	1.900 u.
9	5	1.900 u.
10	5	1.822 u.
	6	1.934
11	3	1.692 u.
12	-------	-------
13	4	1.838 u.
14	5	1.882 u.
15	5	1.929 u.+
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20		
	1	1.929
21	-------	-------
22	-------	-------
23	-------	-------
24	-------	-------
25	5	1.859 u.
26	5	1.891 u.
27	5	1.910 u.
28	4	1.930 u.+
29	5	1.926 u.+
30	5	1.918 u.+
31	-------	-------
	3	1.925
Monthly mean	10	1.931
Aug. 1	-------	-------
2	-------	-------
3	-------	-------
4	5	1.894 u.
5	4	1.929 u.+
6	4	1.920 u.+
7	5	1.937 s.−
8	4	1.886 u.
9	5	1.936 u.+
10	-------	-------
	4	1.930

Table 33.—*Solar-constant values. Short method. Mount Brukkaros, 1926–1930*—Continued

Date	Number of values	S. C. and grade
1930		
Aug. 11	-------	-------
12	5	1.918 u.+
13	5	1.923 u.+
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	-------	-------
	2	1.920
21	5	1.916 u.+
22	5	1.914 u.+
23	5	1.930 u.+
24	5	1.928 u.+
25	4	1.946 u.+
26	5	1.941 u.+
27	5	1.964 u.
28	4	1.928 u.+
29	4	1.940 u.+
30	-------	-------
31	4	1.922 u.+
	9	1.929
Monthly mean	15	1.928
Sept. 1	5	1.915 u.+
2	-------	-------
3	5	1.922 u.+
4	5	1.928 u.+
5	5	1.899 u.
6	5	1.894 u.
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	3	1.922
11	4	1.875 u.
12	4	1.895 u.
13	5	1.930 s.−
14	5	1.926 s.−
15	5	1.931 s.−
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------

Date	Number of values	S. C. and grade
1930		
Sept. 20	5	1.848 u.
	3	1.929
21	-------	-------
22	-------	-------
23	4	1.923 u.+
24	4	1.897 u.
25	5	1.930 s.−
26	-------	-------
27	4	1.934 s.−
28	5	1.910 u.
29	4	1.908 u.
30	5	1.907 u.
	2	1.928
Monthly mean	8	1.926
Oct. 1	5	1.935 s.−
2	-------	-------
3	-------	-------
4	-------	-------
5	4	1.934 s.−
6	5	1.920 s.−
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	3	1.930
11	5	1.924 s.−
12	5	1.920 s.−
13	4	1.932 s.−
14	5	1.930 s.−
15	5	1.920 s.−
16	5	1.927 s.−
17	4	1.940 s.−
18	5	1.914 s.−
19	-------	-------
20	-------	-------
	8	1.926
21	-------	-------
22	5	1.914 u.+
23	5	1.924 u.+
24	-------	-------
25	-------	-------
26	-------	-------

Date	Number of values	S. C. and grade
1930		
Oct. 27	-------	-------
28	-------	-------
29	5	1.907 u.
30	5	1.889 u.
31	4	1.930 u.+
	2	1.923
Monthly mean	13	1.927
Nov. 1	4	1.941 s.−
2	5	1.922 s.−
3	4	1.932 s.−
4	4	1.974 u.
5	3	1.944 u.+
6	-------	-------
7	-------	-------
8	-------	-------
9	-------	-------
10	-------	-------
	4	1.935
11	-------	-------
12	-------	-------
13	5	1.916 u.+
14	5	1.904 u.
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	-------	-------
20	5	1.923 s.−
	2	1.920
21	5	1.932 s.−
22	5	1.933 s.−
23	5	1.929 s.−
24	-------	-------
25	-------	-------
26	-------	-------
27	-------	-------
28	5	1.943 s.−
29	-------	-------
30	5	1.922 u.+
	5	1.932
Monthly mean	11	1.931

Date	Number of values	S. C. and grade
1930		
Dec. 1	5	1.933 s.−
2	5	1.932 s.−
3	-------	-------
4	-------	-------
5	-------	-------
6	4	1.941 s.−
7	5	1.930 s.−
8	-------	-------
9	-------	-------
10	5	1.950 s.−
	5	1.937
11	5	1.946 s.−
12	-------	-------
13	-------	-------
14	-------	-------
15	-------	-------
16	-------	-------
17	-------	-------
18	-------	-------
19	5	1.960 u.
20	-------	-------
	1	1.946
21	5	1.945 s.−
22	-------	-------
23	5	1.929 s.−
24	5	1.931 s.−
25	5	1.940 s.−
26	-------	-------
27	-------	-------
28	-------	-------
29	-------	-------
30	-------	-------
31	5	1.955 s.−
	6	1.940
Monthly mean	11	1.939

Chapter VI

DISCUSSION OF RESULTS

1. NUMBERS OF OBSERVATIONS

In the year 1920 solar-constant stations were established at Montezuma, Chile, and Mount Harqua Hala, Ariz. The latter station was removed to Table Mountain, Calif., in December, 1925. In December, 1926, a station was established at Mount Brukkaros, Southwest Africa. The following table gives the total number of days, including the year 1930, on which solar-constant observations were made at these several stations:

TABLE 34*a*.—*Number and classes of reduced observations,*[1] *Montezuma, 1920–1930*

Date	Total	S [2]	S–	U	L
1920					
January	--------	--------	--------	--------	--------
February	--------	--------	--------	--------	--------
March	--------	--------	--------	--------	--------
April	--------	--------	--------	--------	--------
May	--------	--------	--------	--------	--------
June	--------	--------	--------	--------	--------
July	--------	--------	--------	--------	--------
August	27	20	7	--------	15
September	25	20	4	1	18
October	22	11	10	1	10
November	25	14	11	--------	9
December	21	15	6	--------	4
	120	80	38	2	56
1921					
January	9	5	4	--------	1
February	7	3	4	--------	--------
March	13	2	10	1	--------
April	16	3	13	--------	--------
May	13	9	3	1	--------
June	17	10	7	--------	1
July	18	10	7	1	--------
August	1	1	--------	--------	--------
September	5	4	1	--------	5
October	13	9	2	2	9
November	15	13	1	1	7
December	12	10	1	1	2
	139	79	53	7	25

[1] Observations not completely reduced because of too unfavorable sky conditions are omitted from this table.
[2] S=satisfactory; S–=nearly satisfactory; U=unsatisfactory; L=long method.

TABLE 34a.—*Number and classes of reduced observations, Montezuma, 1920–1930*—Continued

Date	Total	S	S−	U	L
1922					
January	19	12	6	1	9
February	11	6	3	2	11
March	16	1	10	5	6
April	13	9	2	2	1
May	6	2	2	2	1
June	11	4	6	1	1
July	8	2	6		
August	10	1	9		1
September	6	2	2	2	
October	10	7	2	1	2
November	9	2	6	1	1
December	6	2	3	1	
	125	50	57	18	33
1923					
January	2		1		2
February	11	11			4
March	27	22	5		11
April	28	27		1	20
May	15	11	2	2	8
June	25	19	4	2	14
July	26	21	5		6
August	28	23	4	1	4
September	29	23	3	3	5
October	28	19	7	2	4
November	26	14	4	8	3
December	19	5	5	9	2
	264	195	40	28	83
1924					
January	25	13	10	2	4
February	22	5	9	8	3
March	28	17	7	4	4
April	25	13	8	4	4
May	30	23	3	4	4
June	23	11	9	3	4
July	28	22	5	1	4
August	24	12	5	7	6
September	26	12	9	5	3
October	28	16	9	3	4
November	27	16	10	1	5
December	25	4	14	7	14
	311	164	98	49	59

TABLE 34*a*.—*Number and classes of reduced observations, Montezuma, 1920–1930*—Continued

Date	Total	S	S–	U	L
1925					
January	24	4	10	10	10
February	14	1	3	10	3
March	27	2	14	11	18
April	26	14	7	5	16
May	28	25	2	1	16
June	24	22	1	1	15
July	29	18	5	6	8
August	25	19	5	1	2
September	28	21	5	2	4
October	26	16	5	5	4
November	23	14	9	-------	2
December	23	11	7	5	2
	297	167	73	57	100
1926					
January	20	3	8	9	1
February	16	4	5	7	1
March	21	7	10	4	2
April	30	25	3	2	4
May	25	19	4	2	2
June	20	13	3	4	0
July	30	24	4	2	3
August	20	16	0	4	2
September	23	19	2	2	0
October	29	21	3	5	3
November	23	6	8	9	2
December	16	8	3	5	0
	273	165	53	55	20
1927					
January	19	8	4	7	1
February	15	6	5	4	1
March	18	6	6	6	1
April	24	18	5	1	4
May	25	21	2	2	3
June	24	19	5	0	3
July	27	25	1	1	3
August	28	26	2	0	4
September	25	17	3	5	2
October	26	15	7	4	3
November	22	15	3	4	3
December	22	9	7	6	2
	275	185	50	40	30

TABLE 34*a*.—*Number and classes of reduced observations, Montezuma, 1920–1930*—Continued

Date	Total	S	S—	U	L
1928					
January	22	8	7	7	2
February	20	9	7	4	1
March	27	8	13	6	2
April	26	12	9	5	2
May	29	14	12	3	3
June	24	6	13	5	1
July	29	16	8	5	3
August	21	10	8	3	3
September	18	5	5	8	1
October	29	19	6	4	4
November	25	3	18	4	2
December	24	5	13	6	3
	294	115	119	60	27
1929					
January	13	2	6	5	1
February	21	3	9	9	1
March	25	12	7	6	2
April	30	29	1	0	5
May	26	16	7	3	5
June	20	12	8	0	4
July	29	22	7	0	6
August	26	14	9	3	4
September	28	7	20	1	6
October	17	5	11	1	2
November	26	8	16	2	6
December	25	7	16	2	4
	286	137	117	32	46
1930					
January	15	0	12	3	1
February	17	1	15	1	3
March	28	5	23	0	5
April	28	10	14	4	5
May	21	7	12	2	4
June	27	9	18	0	5
July	30	10	19	1	4
August	22	10	9	3	5
September	23	10	8	5	3
October	27	11	15	1	5
November	25	6	13	6	5
December	26	10	15	1	3
	289	89	173	27	48
Total	2, 673	1, 426	871	375	527

TABLE 34*b*.—*Number and classes of reduced observations,*[1] *Table Mountain, 1925–1930*

Date	Total [2]	S— [3]	U+	U	L
1925					
December	14	4	5	5	9
1926					
January	22	14	2	6	16
February	14	9	5	0	9
March	16	10	2	2	12
April	15	8	3	2	10
May	21	9	1	5	16
June	22	15	1	6	12
July	23	21	0	1	9
August	23	15	3	4	3
September	28	25	2	1	7
October	31	27	1	3	6
November	19	15	1	3	1
December	20	16	1	3	2
	254	184	22	36	103
1927					
January	13	8	3	2	2
February	10	8	1	1	4
March	17	14	0	3	4
April	27	19	1	7	5
May	27	19	1	7	5
June	21	13	1	5	4
July	20	14	4	1	3
August	26	19	0	5	16
September	25	19	4	2	6
October	24	22	0	2	5
November	22	19	2	1	6
December	20	18	1	1	3
	252	192	18	37	63
1928					
January	23	16	2	4	6
February	22	16	5	1	4
March	20	15	1	3	5
April	23	14	1	6	3
May	14	0	3	6	6
June	29	15	2	12	4
July	22	17	1	4	4
August	24	17	1	5	6

[1] Observations not completely reduced because of too unfavorable sky conditions are omitted from this table. The total numbers including uncompleted days are given in Table 1, with which the totals in this table afford an interesting comparison.

[2] Total includes all dates completely reduced, whether by short or long methods.

[3] S— = nearly satisfactory. No Table Mountain values are graded "satisfactory." That grade is reserved for the best values at Montezuma. U+ = barely good enough to be included in the mean values. U = unsatisfactory—excluded from mean values. L = long method.

TABLE 34*b*.—*Number and classes of reduced observations, Table Mountain, 1925–1930*—Contd.

Date	Total	S−	U+	U	L
1928					
September	24	11	4	9	6
October	23	20	0	3	4
November	19	17	1	1	5
December	26	24	0	1	18
	269	182	21	55	71
1929					
January	18	13	2	3	12
February	18	15	2	1	8
March	20	11	2	6	10
April	21	11	3	4	9
May	25	12	2	7	10
June	14	7	0	7	9
July	18	8	5	5	7
August	14	3	5	2	10
September	25	20	0	5	8
October	23	16	2	5	7
November	29	26	2	1	8
December	23	16	5	2	9
	248	158	30	48	107
1930					
January	14	9	3	2	4
February	20	13	2	5	8
March	16	9	2	2	8
April	16	9	1	3	7
May	15	7	3	1	8
June	24	20	3	0	10
July	23	20	2	0	10
August	23	19	0	1	9
September	27	22	5	0	9
October	30	26	2	2	9
November	20	19	1	0	9
December	24	21	1	1	8
	251	194	25	17	99
Total	1, 288	914	121	218	452

TABLE 34c.—*Number and classes of reduced observations,*[1] *Mount Brukkaros, 1926–1930*

Date	Total	S−	U+	U	L
1926					
December	9	6	1	1	2
1927					
January	10	6	1	3	4
February	17	13	3	0	2
March	16	14	2	0	3
April	20	16	2	2	5
May	22	12	3	7	12
June	15	6	2	7	11
July	26	14	0	12	18
August	13	8	0	3	8
September	13	6	0	5	6
October	6	5	0	1	1
November	12	11	0	1	4
December	16	16	0	0	2
	186	127	13	41	76
1928					
January	20	12	4	4	3
February	19	13	2	4	1
March	16	7	5	4	2
April	22	20	1	1	5
May	27	15	6	6	6
June	29	12	5	12	5
July	18	7	4	7	2
August	15	5	6	4	7
September	16	9	4	3	3
October	18	13	2	3	5
November	9	7	1	1	1
December	12	9	1	1	2
	221	129	41	50	42
1929					
January	7	5	0	0	2
February	11	11	0	0	5
March	19	11	7	1	2
April	21	12	8	1	4
May	19	12	4	3	6
June	21	11	4	6	5
July	26	11	6	9	7
August	12	8	1	3	1
September	13	4	2	7	0
October	19	6	4	9	3

[1] Observations not completely reduced because of too unfavorable sky conditions are omitted from this table.

Table 34c—*Number and classes of reduced observations, Mount Brukkaros, 1926–1930*—Con.

Date	Total	S−	U+	U	L
1929					
November	19	17	0	1	4
December	18	16	0	0	4
	205	124	36	40	43
1930					
January	19	17	2	0	1
February	17	10	4	3	3
March	22	13	6	3	6
April	27	26	0	1	5
May	29	20	3	6	1
June	27	10	4	13	6
July	20	4	6	10	3
August	18	1	14	3	6
September	18	5	4	9	5
October	14	11	3	0	2
November	12	8	2	2	4
December	13	11	0	1	2
	236	136	48	51	44
Total	857	522	139	183	207

2. AGREEMENT BETWEEN METHODS

The long method is fundamental, the short method empirical. The long method yields but one solar-constant value per day, the short method often yields five. Variations of atmospheric transparency during the period of observing are apt to affect long-method values, but such sources of error are negligible with the short method. Only the most cloudless days are available for the long method, while short-method observations have been attempted on many days marred by numerous clouds or thick haze. Some of these days, of course, have proved quite worthless and have been wholly rejected.

In the following table is given the average deviation between groups of long-method and short-method solar-constant observations at Montezuma in all months when results of fairly satisfactory quality were reached by both methods. We give these data to show that the empirical methods have not seriously diverged from the fundamental one.

TABLE 35a.—*Comparison of mean results of groups of solar-constant values. Long and short methods. Montezuma, 1920–1930*

Date		Long method		Short method		Long minus short
		S. C. values	Number observations	S. C. values	Number observations	
1920	August	1. 934	15	1. 930	27	+0. 004
	September	. 944	18	. 947	25	− . 003
	October	. 945	10	. 944	22	+ . 001
	November, December	. 959	9	. 954	55	+ . 005
1921	January					
	September	. 959	5	. 969	5	− . 010
	October	. 952	9	. 962	11	− . 010
	November, December	. 945	8	. 952	26	− . 007
1922	January	. 953	9	. 948	19	+ . 005
	February	. 951	11	. 943	9	+ . 008
	March	. 945	6	. 938	11	+ . 007
	April to November	. 944	7	. 924	54	+ . 020
1923	January, February	. 960	6	. 938	12	+ . 022
	March	. 942	11	. 932	27	+ . 010
	April	. 945	20	. 932	13	+ . 013
	May	. 941	8	. 936	13	+ . 005
	June	. 952	14	. 928	23	+ . 024
	July, August	. 944	10	. 939	54	+ . 005
	September, October	. 954	9	. 942	55	+ . 012
	November, December	. 943	5	. 937	37	+ . 006
1924	January, February	. 953	7	. 940	40	+ . 013
	March, April	. 929	8	. 945	45	− . 016
	May, June	. 935	8	. 952	46	− . 017
	July, August	. 932	10	. 943	36	− . 011
	September, October	. 942	7	. 947	48	− . 005
	November, December	. 941	19	. 945	46	− . 004
1925	January, February	. 934	13	. 943	20	− . 009
	March	. 937	18	. 939	22	− . 002
	April	. 943	16	. 947	21	− . 004
	May	. 941	16	. 950	27	− . 009

Table 35a.—*Comparison of mean results of groups of solar-constant values. Long and short methods. Montezuma, 1920–1930*—Continued

Date	Long method S. C. values	Long method Number observations	Short method S. C. values	Short method Number observations	Long minus short
1925.. June	1.940	15	1.945	23	−0.005
July, August	.935	10	.948	47	−.013
September, October	.946	8	.948	47	−.002
November to 1926.. February	.938	6	.942	70	−.004
March to May	.937	8	.937	73	.000
July to October	.929	8	.940	70	−.011
November to 1927.. March	.924	5	.938	60	−.014
April, May	.937	7	.944	47	−.007
June, July	.933	6	.945	51	−.012
August to October	.946	9	.943	70	+.003
November to 1928.. February	.951	7	.942	65	+.009
March to June	.941	7	.946	87	−.005
July to October	.941	10	.934	77	+.007
November to 1929.. February	.921	7	.931	59	−.010
March, April	.944	7	.934	49	+.010
May, June	.943	9	.936	43	+.007
July, August	.943	10	.932	52	+.011
September, October	.933	8	.929	43	+.004
November, December	.938	10	.938	47	.000

Table 35a.—*Comparison of mean results of groups of solar-constant values. Long and short methods. Montezuma, 1920–1930*—Continued

Date	Long method		Short method		Long minus short
	S. C. values	Number observations	S. C. values	Number observations	
1930 January, February, March	1.938	9	1.938	59	0.000
April, May	.941	9	.942	48	−.001
June, July	.945	9	.945	56	.000
August, September	.944	8	.941	46	+.003
October to December	.941	12	.944	70	−.003

Mean deviation regarding signs, +0.0005.
Mean deviation disregarding signs, ±0.0078.

Table 35b.—*Comparison of mean results of groups of solar-constant values. Table Mountain long methods and mean of Table Mountain and Montezuma short methods*

Date	Long method corrected for pyrheliometry [1]	Number	Short method	Deviation short minus long	Deviation [2, 3] corrected for scale
1925 December	1.909	9	1.943	0.034	+0.023
1926 January	.914	16	.940	.026	+ .015
February	.909	9	.935	.026	+ .015
March	.928	12	.936	.008	− .003
April	.909	10	.937	.028	+ .017
May	.928	16	.938	.010	− .001
June	.943	12	.943	.000	− .011
July	.938	9	.941	.003	− .008
August, September	.932	10	.942	.010	− .001
October, November, December	.936	8	.935	−.001	− .012
1927 January, February	.927	6	.942	.015	+ .004
March, April	.934	9	.944	.010	− .001

[1] As explained before Table 31, all Table Mountain values from November, 1929, to December, 1930, should be increased 0.008 calories for imperfect pointing of pyrheliometers.

[2] A scale difference averaging −0.011 between Table Mountain long methods and the mean of Montezuma and Table Mountain short methods is here removed.

[3] The average values in this column are as follows:

Jan.–Feb.	Mar.–Apr.	May–June	July–Aug.	Sept.–Oct.	Nov.–Dec.
+.0040	−.0016	−.0044	+.0028	+.0002	−.0084

These averages indicate only a slight yearly march of deviation of the short method from the long.

Table 35*b*.—*Comparison of mean results of groups of solar-constant values. Table Mountain long methods and mean of Table Mountain and Montezuma short methods*—Continued

Date	Long method corrected for pyrheliometry	Number	Short method	Deviation short minus long	Deviation corrected for scale
1927 May, June	1. 931	9	1. 946	0. 015	+ 0. 004
July, August	. 932	16	. 945	. 013	+ . 002
September, October	. 935	11	. 944	. 009	− . 002
November, December	. 940	9	. 941	. 001	− . 010
1928 January, February	. 933	10	. 940	. 007	− . 004
March, April	. 933	8	. 945	. 012	+ . 001
May, June	. 953	10	1. 948	−. 007	− . 018
July, August	. 927	10	. 940	. 013	+ . 002
September, October	. 920	10	. 929	. 009	− . 002
November, December	. 922	23	. 928	. 006	− . 005
1929 January, February	. 916	20	. 932	. 016	+ . 005
March, April	. 931	19	. 932	. 001	− . 010
May, June	. 933	19	. 935	. 002	− . 009
July, August	. 913	17	. 932	. 019	+ . 008
September, October	. 915	15	. 930	. 015	+ . 004
November, December	. 925	17	. 939	. 014	+ . 003
1930 January, February	. 928	12	. 939	. 011	. 000
March, April	. 932	14	. 938	. 006	− . 005
May, June	. 925	16	. 943	. 018	+ . 007
July, August	. 929	19	. 945	. 016	+ . 005
September, October	. 922	18	. 937	. 015	+ . 004
November, December	. 930	17	. 939	. 008	− . 003

Mean deviation, +0.0114.
Mean corrected deviation, ±0.0066.

Table 35c.—*Comparison of mean results of groups of solar-constant values. Mount Brukkaros long methods and mean of Table Mountain and Montezuma short methods*

Date	Long method corrected for pyrheliometry [1]	Number	Mean, short method	Deviation, short minus long [2]
1926 December 1927 January February	1.926	8	1.940	+0.014
March April	.944	8	.943	−.001
May	.948	12	.945	−.003
June	.938	11	.947	+.009
July	.949	18	.946	−.003
August	.954	8	.943	−.011
September October	.947	7	.944	−.003
November December	.942	6	.942	.000
1928 January February March	.927	5	.942	+.015
April May	.943	11	.946	+.003
June July	.942	6	.946	+.004
August September	.941	10	.934	−.007
October November December	.921	7	.929	+.008
1929 January February March	.928	9	.931	+.003
April May	1.942	10	1.936	−.006
June July	.941	13	.934	−.007
October November December	.942	10	.936	−.006
1930 January February March	.941	10	.939	−.002
April May June July	.943	14	.943	.000
August September	.941	11	.941	.000
November December	.941	8	.939	−.002

[1] An injury occurred to the pyrheliometers during the long journey from Washington to Mount Brukkaros. They were repaired at the station but could not be restandardized, and, as it now appears, read about 3 per cent high. By extensive comparisons with Montezuma, the following scale corrections to Mount Brukkaros values were fixed: Prior to Nov. 1, 1927, minus 2.4 per cent; Nov. 1 to Dec. 8, 1927, minus 2.9 per cent; thereafter, minus 3.7 per cent. The values as given here and in Table 33 are corrected for all of these changes of scale.

[2] Average deviation, ±0.0051 cal., or ±0.27 per cent.

3. AGREEMENT BETWEEN STATIONS. DAILY VALUES

It is apparent from data previously given that Montezuma is decidedly the best of the stations occupied. In comparing results, therefore, we prefer to express deviations as between Montezuma and each of the other stations. Such comparisons indicate how small are the solar variations which we may expect the results to be accurate enough to disclose. In making these comparisons we take account only of days observed in common at Montezuma and the station compared, and of these, only days when fairly satisfactory short-method observations of the solar constant were secured at each station. As we are concerned here with solar variations and not with absolute values, all results have been reduced arbitrarily to a common scale, and thereby certain systematic differences have been elminated. The differences here considered are therefore due principally to accidental sources of error. Yet if there exist systematic errors, due, for instance, to yearly marches in haziness, humidity, personal equation, or pyrheliometry, such sources of error are not eliminated here and must have increased the deviations summarized in the following table:

TABLE 36.—*Comparison of Montezuma and Table Mountain solar-constant values of individual days, December, 1925, to December, 1930, inclusive*

Number of days compared	Mean difference between stations		For single station and single day		Probable error of mean of two stations, per cent
	In calories	In per cent	Average deviation, per cent	Probable error, per cent	
699	0. 0079	0. 41	0. 29	0. 24	0. 17

4. AGREEMENT BETWEEN STATIONS. MONTHLY VALUES

It is to be expected that the deviations between stations will be reduced when mean values of groups of days are being compared. On the other hand, the extremes of real solar variation will be cut off in such grouping, so that accidental error will not be reduced so much proportionally to changes of solar radiation as it is absolutely. In making this comparison, Montezuma still is made the standard of reference. Means of monthly intervals have been taken to include all fairly satisfactory short-method values, whether coincident between the stations or not. Hence the deviations given are somewhat larger than accidental errors alone would produce, because real variations of the sun are not excluded entirely.

Owing to a press of time and to the fact that the data are shown graphically in Figure 26A, a tabular comparison between Montezuma and Mount Brukkaros similar to the following Table 37 is omitted.

TABLE 37.—*Comparison of monthly mean solar-constant values*

[Unit 0.001 calorie. First two figures omitted. Thus for 45 read 1.945]

Date	Montezuma mean and number	Table Mountain mean and number	Montezuma minus Table Mountain	Date	Montezuma mean and number	Table Mountain mean and number	Montezuma minus Table Mountain
1925				1928			
January	-- --	-- --	--	January	40 15	35 18	+5
February	-- --	-- --	--	February	43 16	42 21	+1
March	-- --	---- --	--	March	46 21	47 16	−1
April	-- --	-- --	--	April	42 21	46 15	−4
May	-- --	-- --	--	May	47 26	-- --	--
June	-- --	-- --	--	June	48 19	51 17	−3
July	-- --	-- --	--	July	42 24	42 18	0
August	-- --	-- --	--	August	37 18	37 18	0
September	-- --	-- --	--	September	27 10	36 13	−9
October	-- --	-- --	--	October	30 25	25 20	+5
November	-- --	-- --	--	November	29 21	29 18	0
December	45 18	40 8	+5	December	26 18	31 24	−5
1926				1929			
January	41 17	38 16	+3	January	38 8	30 15	+8
February	38 12	31 13	+7	February	29 12	32 17	−3
March	39 20	32 12	+7	March	31 19	29 13	+2
April	34 29	40 11	−6	April	37 30	30 15	+7
May	39 24	42 10	−3	May	38 23	38 14	0
June	44 19	41 16	+3	June	34 20	31 7	+3
July	44 28	37 21	+7	July	33 29	35 13	−2
August	44 17	41 18	+3	August	31 23	31 9	0
September	42 21	40 27	+2	September	28 27	32 20	−4
October	34 25	36 28	−2	October	29 16	33 18	−4
November	29 18	37 16	−8	November	36 24	37 28	−1
December	32 11	43 17	−11	December	40 23	42 21	−2
1927				1930			
January	38 16	44 11	−6	January	36 12	45 12	−9
February	43 12	42 9	+1	February	38 16	39 15	−1
March	42 14	45 14	−3	March	39 27	36 11	+3
April	44 23	45 20	−1	April	40 24	38 10	+2
May	45 24	45 20	0	May	44 19	41 10	+3
June	46 24	48 14	−2	June	43 27	43 23	0
July	45 27	47 18	−2	July	47 29	45 22	+2
August	41 28	46 19	−5	August	45 19	42 19	+3
September	44 20	47 23	−3	September	37 18	38 27	−1
October	44 22	44 22	0	October	40 26	33 28	+7
November	44 18	41 21	+3	November	44 19	31 20	+13
December	42 16	37 19	+5	December	47 25	33 23	+14

General mean difference, Montezuma minus Table Mountain, regarding sign, 0.0004 cal.
General mean difference, Montezuma minus Table Mountain, disregarding sign, 0.0037 cal.
Average probable error of a monthly mean value, the mean of two stations, 0.08 per cent.

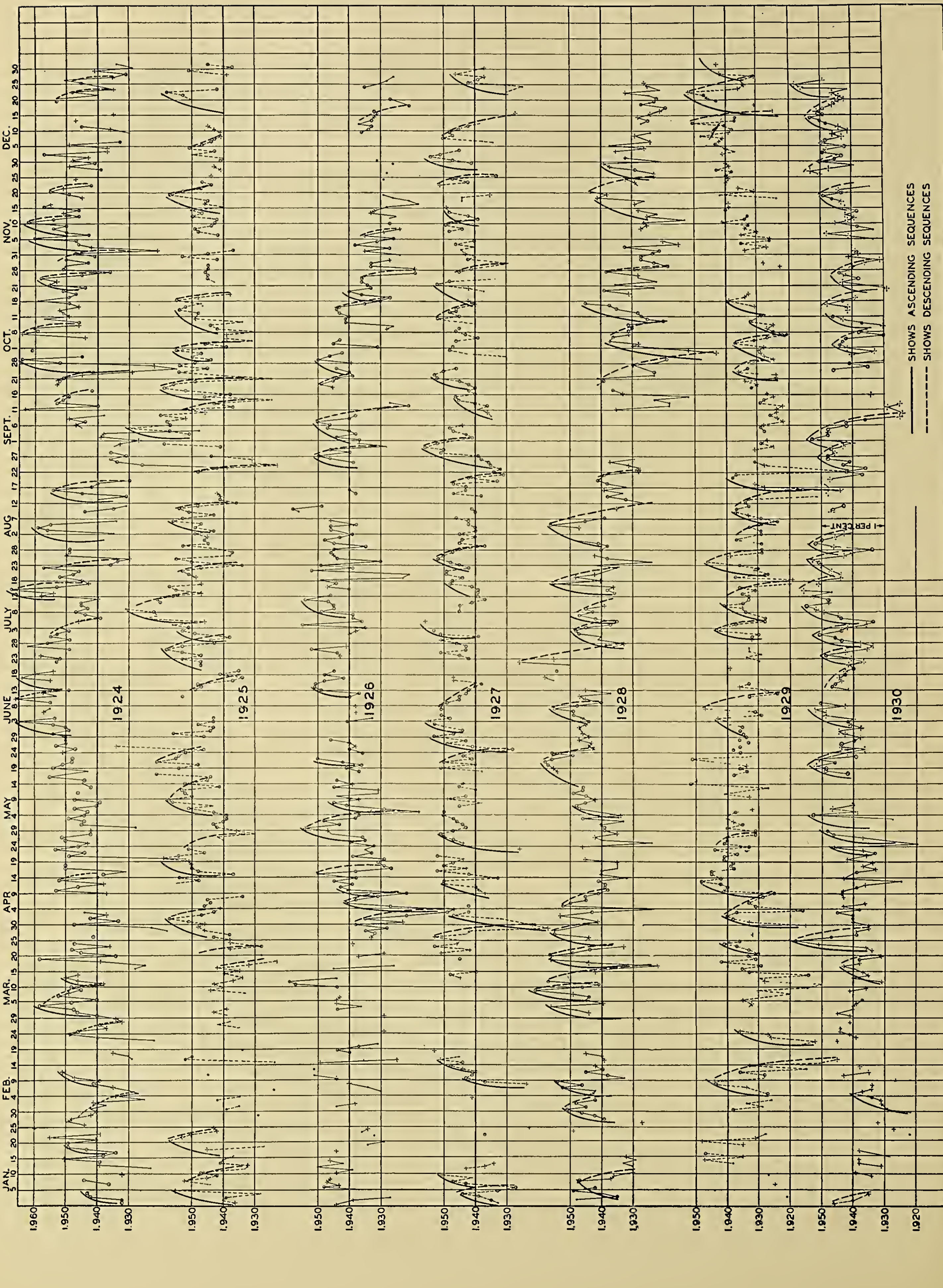

Figure 23.—Solar variation measurements at Montezuma since 1924

5. TESTIMONY OF STATIONS AS TO SOLAR VARIATIONS

(*a*) *Short-interval variations.*—In Figure 23 we give the daily observations of the sun as determined at Montezuma. We have marked thereon by curved lines, full and dotted respectively, 111 cases of rising and 106 cases of falling sequences. During these periods the solar constant of radiation appeared to rise or to fall by gradual stages, extending through some four or five consecutive days, through ranges of from 0.45 to 2.5 per cent.

Owing to cloudiness or defective observations, not all of these cases of ascending and descending sequences observed at Montezuma are well represented at other stations. Rejecting periods when fairly satisfactory observations did not occur simultaneously at Table Mountain in the years 1926 to 1930, inclusive, there remain of the total numbers of cases found at Montezuma (81 and 68, respectively), 41 cases at Table Mountain corresponding to the ascending Montezuma sequences, and 37 cases there corresponding to the descending ones. If, now, the two stations agree on the whole in their testimony as to ascending and descending solar sequences, then the algebraic sum of the departures at Table Mountain should be in the same sense as at Montezuma. In taking these sums it will be understood, of course, that we shall use the same dates at both stations for the beginning and end of each sequence.

Inasmuch as accidental errors of observations must certainly affect both Montezuma and Table Mountain observations, it must sometimes have happened that a supposed solar change at Montezuma was really accidental, and it must also sometimes have happened that when a real solar change was fairly accurately recorded at Montezuma the observation of it at Table Mountain was defective. Hence, it is obvious that the numerical values of the algebraic sums of the ranges of the sequences at Table Mountain must inevitably be smaller than the corresponding sums at Montezuma. Furthermore, the very great difficulty which, as we have stated, was experienced in finding a method of reducing the Table Mountain observations so as to eliminate atmospheric errors satisfactorily, must convince us that Table Mountain as a solar-constant station is very much inferior to Montezuma. Hence, an incomplete agreement in the test we are describing, indicated by a considerable discrepancy between the sums of the sequences as revealed in the following table, need not prejudice us against the general validity of the solar changes indicated by the more accurate results of Montezuma. We shall later present other evidence in favor of the greater validity of the Montezuma results.

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TABLE 38.—*Sums of sequence ranges, Montezuma and Table Mountain*

[Unit is 0.001 calorie]

Year	Ascending sequences			Descending sequences		
	Number	Sums		Number	Sums	
		Montezuma	Table Mountain		Montezuma	Table Mountain
1926	7	+82	+127	9	−126	−35
1927	11	+123	+110	5	−70	−35
1928	6	+100	+68	9	−121	−117
1929	8	+95	+53	2	−16	−22
1930	9	+132	+81	12	−178	−100
Total	41	532	439	37	−511	−309

It is favorable that the signs of the sums agree. Considering the influences mentioned above which tend to diminish numerically the Table Mountain sums as compared to those of Montezuma, we regard the result of this test as surprisingly strongly verifying the validity of the sequences of short-interval solar variation discovered at Montezuma.

The preceding comparison is not thoroughly satisfactory because of the accidental irregularities within the sequences as observed both at Montezuma and Table Mountain. If the end dates of a sequence indicate favorably, nevertheless they may not fairly represent the course of the sequence owing to discrepancies occurring on intermediate dates.

Another method wholly independent of the comparer's judgment consists first in assembling in unbroken consecutive order all of the simultaneous observations of both stations which are entirely or nearly satisfactory. All intermediate dates when such observations are lacking, either at one or at both stations, are omitted. Next, the successive differences between consecutive observations, as thus arranged in a continuous series, are taken for each station. Employing the better station, Montezuma, as the master station, all of the differences for Montezuma are arranged in two columns, the positive differences in one, the negative in the other. Then the differences for Table Mountain are arranged in two columns in which differences, whatever their signs, corresponding to positive differences at Montezuma are in one column and the remainder of the differences in the other. Sums are then taken algebraically of all four columns. The results are as follows:

Number of fairly satisfactory cases in common	699
Average deviation between stations, 0.0079 cal., or per cent	0. 41
Hence probable error of a daily mean result of two stations is per cent	0. 17
Number of cases when differences had a common sign at both stations	421
Number of cases when differences had contrary signs	277
Number of positive Montezuma differences	348
Number of negative Montezuma differences	350
Sum of positive Montezuma differences (unit, 0.001 cal.)	1, 907
Sum of negative Montezuma differences	−1, 921
Algebraic sum of Table Mountain differences corresponding to plus at Montezuma	+471
Algebraic sum of Table Mountain differences corresponding to minus at Montezuma	−330
Total Montezuma range	3, 828
Total Table Mountain range	801
Percentage range Table Mountain compared to Montezuma	20. 9

Again the signs of the sums of the differences agree for the two stations. It is not surprising that the percentage range found in this way at Table Mountain is not larger. The effect of accidental errors is almost inevitably to increase the Montezuma sums, swelling them by the addition of a spurious portion amounting probably to an appreciable fraction of their total. On the contrary, the effect of both Montezuma and Table Mountain errors is almost inevitably to diminish numerically, relatively to Montezuma, the Table Mountain algebraic sums. Montezuma errors will do this because they will frequently throw differences into the wrong column, and Table Mountain errors will do this because the totals are taken algebraically, and the Table Mountain errors tend to be equal and opposite, and so to produce a total of zero.

On the whole, despite shortcomings, this entirely impersonal comparison confirms the conclusion found by the comparison of sequences. The two stations agree that short-interval solar changes really occur. Nevertheless, it is a very great pity that the observations are not a little more free from accidental error. The results to be given in section 7 seem to show that solar changes observed at Montezuma are associated with weather changes at distant parts of the world. Apparently, observed solar changes as small as 0.45 per cent are of importance in weather influence, paradoxical though it may seem. But this magnitude of solar change is so near the magnitude of the probable error of the observations that, in accordance with the usual laws of distribution of error, many changes must be observed larger than 0.45 per cent in magnitude, which are only accidental, not solar. These may even seem to form gradually progressing sequences in some cases. It is very needful, if it is possible, to find and equip other stations, equal to Montezuma, where duplicate observations of the highest weight may be made regularly. Even at Montezuma we fear that the accuracy just falls short of what is required. Fortunately there is good hope of making several improvements which should appreciably diminish the experimental error at all of the stations.

In order to show the reader at the same time evidences of agreement and of disagreement between the results of Montezuma and Table Mountain, we give in Figure 24 nearly all of the cases available, from 1926 to 1930, inclusive, when fairly satisfactory daily observations occurred consecutively at both stations simultaneously over intervals of 10 days or longer. It will be seen from the illustration that in many instances there is a great similarity in the march of the curves. In others, particularly in the latter part of the year 1930, there is dissimilarity. We believe that if Table Mountain were as favorable a station as Montezuma there would have been found much closer agreement and very infrequent pronounced disagreement. The reader will observe that in these brief intervals solar changes exceeding 1.5 per cent are rarely indicated. Hence the accuracy of observing demanded in order to give a true picture of short-interval solar variation is very exacting.

In order to clarify the impression given by the graphical illustration, we have arranged consecutively, without breaks, parallel columns giving the departures from the mean values for each day observed in common during all the intervals shown in Figure 24. We have plotted these differences as shown in Figure 25. Considerably greater extensions toward the first and third quadrants than toward the second and fourth quadrants confirm the existence of real variations shown by the two stations in common. Also confirmatory is the fact that of 698 simultaneous differences, the signs agree for the two stations in 400 cases and disagree in only 298.

FIGURE 24.—Comparison of daily solar-constant values. Montezuma (full) and Table Mountain (dotted)

We desire to suggest again that if both stations were as favorable as Montezuma, the agreement would be much more striking. The superiority of Montezuma must be apparent to the reader from mere inspection of Figure 24, because the Montezuma curve is by far the smoother. To express this numerically, we have taken the sum of consecutive days' differences in the table just mentioned, disregarding signs. The sum of 698 differences for Montezuma is 4,127, while for Table Mountain it is 5,400.

(*b*) *Long-interval variations.*—However imperfect the evidence of short-interval variations, there can be no doubt of the general harmony of testimony of the stations as to the longer-interval solar fluctuations. It admits of no question in view of Figure 26A, wherein the dotted curve represents the Table Mountain monthly means of solar constants, and the full curve those of Montezuma, of the years 1926

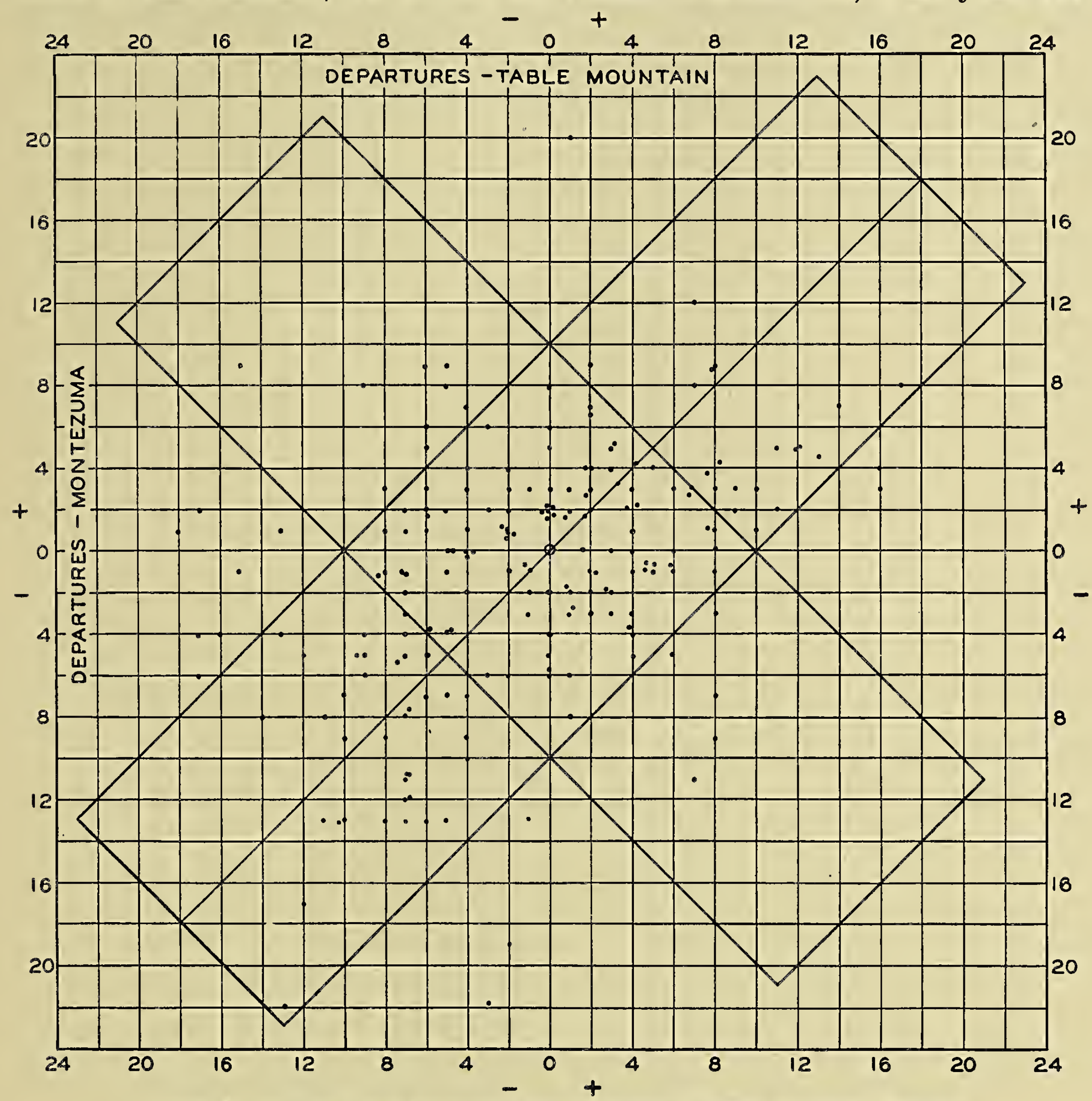

FIGURE 25.—Comparison of daily solar-constant values of Montezuma and Table Mountain by 45° diagram

to 1930, inclusive, [1] and the dot and dash curve the results from Mount Brukkaros, 1927 to 1930. The weighted general mean is indicated by the heavy full line.

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[1] One explanation should be made. The crosses below the curves in the years 1929 and 1930 represent the preliminary results originally found at Table Mountain. Tests by the method of selective pyrheliometry indicated, however, that the pyrheliometers used daily in 1930 read about 0.4 per cent lower than for similar days of previous years. Accordingly it was suspected that the pyrheliometers in daily use, which have very long tubes and closely limiting diaphragms, might be pointing slightly unfavorably so as not to be quite fully exposed. The observers, indeed, had frequently compared them in 1929 and 1930 with the seldom-used standard, A. P. O. 12. But this standard instrument had been introduced late in 1928, prior to which time pyrheliometer S. I. 42 had long been the standard. There was, therefore, a discontinuity in the standard comparisons between 1930 and the earlier years. Accordingly the observers were directed to make extensive comparisons of the usual instruments against the former standard, S. I. 42. With 84 comparisons, 42 of $\frac{\text{S. I. 42}}{\text{A. P. O. 10}}$ and 42 of $\frac{\text{S. I. 42}}{\text{S. I. 32}}$, they found in

As we shall see in the next section, the long-interval solar variations from 1918 to 1930, as observed at Montezuma, are closely represented as the sum of five regular periodicities. Their extreme range during the interval 1926 to 1930, inclusive, is but 1.4 per cent. Yet not only this but much smaller solar changes are harmoniously indicated by the excellent agreement of Montezuma and Table Mountain monthly mean solar-constant values, which differ from each other by the average amount of only ⅕ of 1 per cent.

(*c*) *The spurious supposed 12-month periodicity in solar-constant values.*—Several years ago, Professor Marvin [2] adduced evidence tending, as he thought, to show that the solar-constant values were all affected by a yearly periodicity, presumably of terrestrial origin. According to him, high values were always found in summer in both hemispheres. The Harqua Hala values, indeed, he found went oppositely in this respect, but he suggested that by our method of reduction they had been forced into agreement with those of Montezuma. Professor Marvin's conclusion has recently been quoted and adopted by Doctor Bernheimer.[3]

Professor Marvin rejected Doctor Abbot's contention that Marvin had mistaken a real 11-month solar variation for a spurious 12-month terrestrial influence. We are now in position to present conclusive evidence thereon.

In the following tables we give 5-year and 10-year averages of the monthly mean solar-constant values of Montezuma; and also the first 6-cycle, the last 5-cycle, and the whole 11-cycle averages of the consecutive monthly mean values from January, 1921 to January, 1931. The first two figures are omitted in each number. Thus, for 468 read 1.9468.

Five- and ten-year monthly averages

Years	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1921–1925	468	422	406	400	404	362	402	376	466	448	430	376
1926–1930	366	382	394	394	426	430	422	396	356	354	364	374
1921–1930	417	402	400	397	415	396	412	386	411	401	397	375

Eleven-month periodicity averages

Months	a	b	c	d	e	f	g	h	i	j	k
Means											
First six periods	447	432	442	404	388	375	382	363	437	428	428
Last five periods	426	430	406	422	356	358	350	370	394	404	400
Eleven-period means	437	431	425	412	374	367	367	366	417	417	415

March, 1931, that both of the instruments in daily use read lower with respect to S. I. 42 by 0.38 per cent than they had done on the average from 1926 to October, 1928. As this change in sign and amount agreed almost precisely with that which had been indicated by the method of selected pyrheliometry, the solar-constant values of Table Mountain from November 7, 1929, to December 31, 1930, inclusive, have all been increased by 0.008 cal., and are thus plotted in Figure 25, and thus given in Table 37.

[2] Monthly Weather Review, vol. 53, no. 7, 1925.

[3] Remarks concerning ultra-violet solar radiation. Lund Observatory Circular No. 2, Mar. 31, 1931. Having informed him of the true facts, as stated below, Doctor Bernheimer has informed me that he will publish a correction.

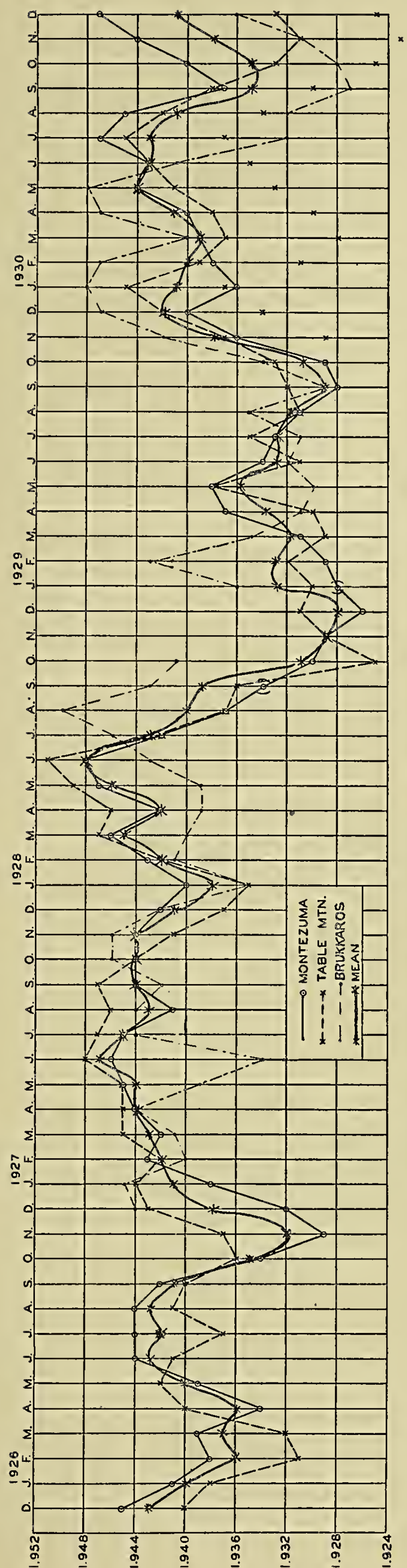

FIGURE 26A.—Monthly mean solar-constant values. Montezuma, Table Mountain and Mount Brukkaros

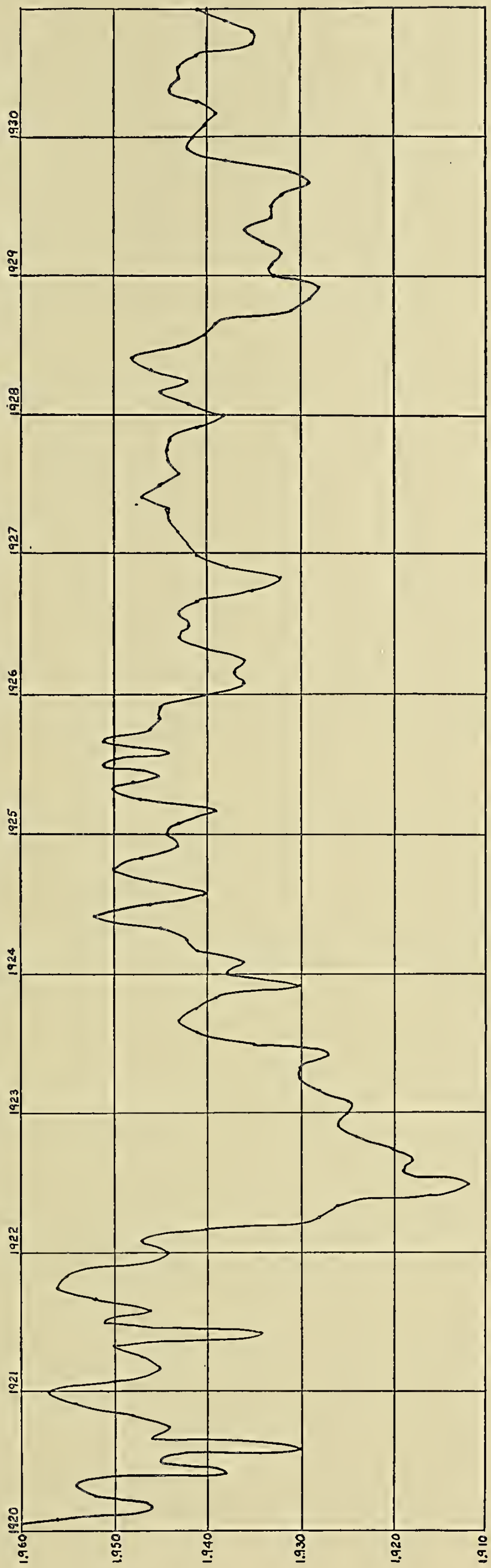

FIGURE 26B.—Preferred monthly mean solar-constant values, 1920–1930

We show these results in Figure 27. Obviously the 12-month period breaks down completely. The first five years are nearly opposite to the last five years, and the ten-year averages show no continuity of march at all, and an extreme range of only 0.2 per cent. Altogether different is the showing of the 11-month periodicity. During the first six cycles, the solar constant averages 0.0020 calorie higher, but as

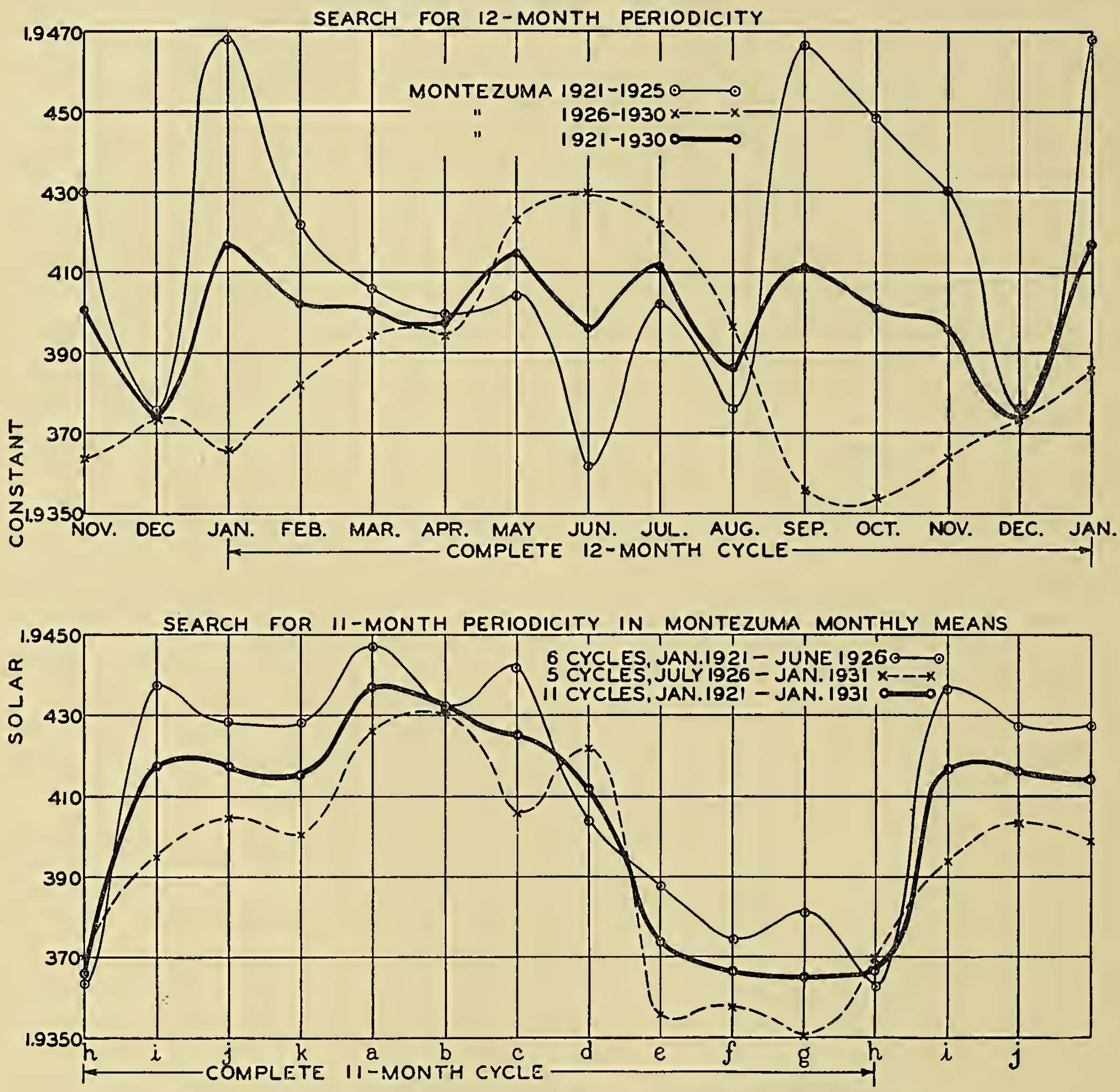

FIGURE 27.—Nonexistence of a supposed 12-month atmospheric influence on solar-constant values

regards variation, the first six cycles agree closely with the last five cycles, and with the general mean of 11 cycles. A range of 0.37 per cent is definitely shown. The minimum occurred from June to August in the year 1921, and at eleven-month intervals regularly thereafter, so that June to August became a maximum in 1927.

The close agreement between Montezuma and Table Mountain proves that the same eleven-month periodicity suits Table Mountain, also.

6. PERIODICITIES IN SOLAR VARIATION

The following pages are quoted from Doctor Abbot's paper, Weather Dominated by Solar Changes.[4]

It would be encouraging from a forecaster's standpoint if definite periodicities should be found in solar variations. In Table 39 are given 10-day mean values of solar radiation from 1918 to 1930.[5] A tendency towards the recurrence of a certain form of 8 months' period was discovered in the 10-day means. To evaluate this periodicity, the 10-day mean values were arranged in a table of 9 lines of 24 consecutive values each, beginning with May, 1924. Mean values of the 24 columns being computed, they resulted thus:

8-month period

Direct means [a]	40	41	42	41	44	41	41	42	41	43	42	40	41	42
Smoothed means	40	41	42	42	43	42	42	42	42	42	41	41	41	41
Smoothed departures	0	+1	+2	+2	+3	+2	+2	+2	+2	+2	+1	+1	+1	+1
Direct means [a]	39	41	40	38	41	41	39	38	37	37				
Smoothed means	41	40	40	40	39	39	39	38	37	37				
Smoothed departures	+1	0	0	0	−1	−1	−1	−2	−3	−3				

[a] First two figures omitted. Thus for 1.940 calories, I substitute 40. Departures are given from 1.940, omitting three figures.

From these numbers a smoothed curve was drawn which gave the departures from 1.940 calories. Subtracting these departures, the original data were cleared of the 8-month periodicity from January, 1924, to December, 1930. It was then perceived that another periodicity of 11 months seemed present. By a similar arrangement in lines of 33 consecutive revised 10-day means of solar-constant numbers, the following values were computed, representing the 11-month periodicity:

11-month period

Direct means	40	41	39	38	38	36	38	39	35	37	37	34	38	40
Smoothed means	41	40	39	38	38	37	37	37	36	36	36	37	38	39
Smoothed departures	1	0	−1	−2	−2	−3	−3	−3	−4	−4	−4	−3	−2	−1
Direct means	40	41	43	44	41	40	38	42	42	40	42	45	43	46
Smoothed means	40	41	42	42	41	40	40	41	41	42	42	43	45	46
Smoothed departures	0	1	2	2	1	0	0	1	1	2	2	3	5	6
Direct means	44	45	43	43	41									
Smoothed means	45	44	43	42	41									
Smoothed departures	5	4	3	2	1									

As these two periodicities had been evaluated solely from results of 1924 to 1930, I desired to see whether they were also in evidence from 1918 to 1923. For this purpose, I made templates fitting the smoothed-curve departures for both periodicities. These templates I traced again and again in their proper phases to fill the entire period from August, 1918, to December, 1930. I then added their amplitudes algebraically. This produced a curve which obviously bore a considerable resemblance to the curve A of Figure 28 throughout its whole extent. This indicated that both 8-and 11-month periodicities have prevailed in solar radiation since 1918.

I now desired to search for longer periodicities. It seemed better to use monthly mean values for this, as given in Table 40 and Figure 28, A. Having read from the curve of combined departures of 8-month and 11-month periodicities the departures for the second decade of each

[4] Smithsonian Miscellaneous Collections, vol. 85, no. 1, 1931.

[5] Chilean results only. The best values are those obtained since January, 1924. Prior to August, 1920, all observations were made in the outskirts of the city of Calama, amid dust and smoke, and with less perfect equipment than subsequently. Prior to January, 1919, there was only one observation per day and by the "long" method. We think possibly there is a discontinuity of scale where the two methods join, and that the values for 1918 are about 1 per cent too high relatively.

month from 1918 to 1930, I subtracted these from curve A, Figure 28, and replotted the again-revised data. This curve seemed to indicate the existence of a periodicity of 45 months. Arranging the corrected solar values in lines of consecutive 45's, and proceeding as previously, the following result appeared:

45-month period

Direct means	29	32	41	35	37	28	41	33	41	44	47	37	43	45
Smoothed means	33	33	34	35	36	37	38	39	40	41	42	43	43	44
Smoothed departures	−7	−7	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+3	+4
Direct means	44	45	41	38	46	46	44	46	41	50	43	43	47	44
Smoothed means	44	45	45	45	46	46	46	46	46	46	45	45	45	45
Smoothed departures	+4	+5	+5	+5	+6	+6	+6	+6	+6	+6	+5	+5	+5	+5
Direct means	44	39	40	40	38	48	40	47	47	41	41	39	40	39
Smoothed means	45	45	45	44	44	43	43	42	41	41	40	39	37	36
Smoothed departures	+5	+5	+5	+4	+4	+3	+3	+2	+1	+1	0	−1	−3	−4
Direct means	36	35	31											
Smoothed means	35	34	33											
Smoothed departures	−5	−6	−7											

After removing the 45-month periodicity as in former cases, there seemed to exist a periodicity of 25 months, which by similar treatment resulted as follows:

25-month period

Direct means	30	33	30	37	34	32	41	38	38	38	38	37	38	44
Smoothed means	32	32	33	34	34	35	35	36	37	38	39	39	40	40
Smoothed departures	−8	−8	−7	−6	−6	−5	−5	−4	−3	−2	−1	−1	0	0
Direct means	41	44	43	40	43	42	42	43	42	40	33			
Smoothed means	40	41	41	42	42	42	42	42	41	40	35			
Smoothed departures	0	+1	+1	+2	+2	+2	+2	+2	+1	0	−5			

Removing the 25-month periodicity, as before, a nearly smooth curve resulted in which the 68-month period corresponding to a half sun-spot period was clearly seen. The coordinates of the five periods discovered are as follows:

Coordinates of periods

Length in months	Amplitude in calories	Date of zero departure
68	.014	Dec. 15, 1929
45	.013	Sept. 15, 1930
25	.010	Nov. 15, 1929
11	.009	Dec. 1, 1929
8	.005	May 1, 1930

I next made templates and traced the five periods hitherto described in a way to cover the entire interval 1918 to 1930. The total effect of the five periodicities is summed up algebraically in curve B, which will be seen to represent the main features and even most details of curve A of Figure 28.[6] Inasmuch as three of the five periodicities which, combined, yield curve B are determined entirely from the work of 1924 to 1930, and the other two are to a large extent thus determined, the part of curve B from 1918 to 1923 may be regarded as if it were a forecast. Its good fit encourages us to expect to see these five periodicities continue to hold until 1933, producing the general march of solar variation forecasted in curve I of Figure 28.

In former publications dealing with possible solar periodicities, I was indebted to Dr. D. C. Miller for the use of his harmonic analyzing machine. Two of the periods which I then thought real, namely, of about 25 months and 11 months, are rediscovered by my present method. I

[6] Regarding descrepancies of 1918 to 1920, see footnote on p. 225.

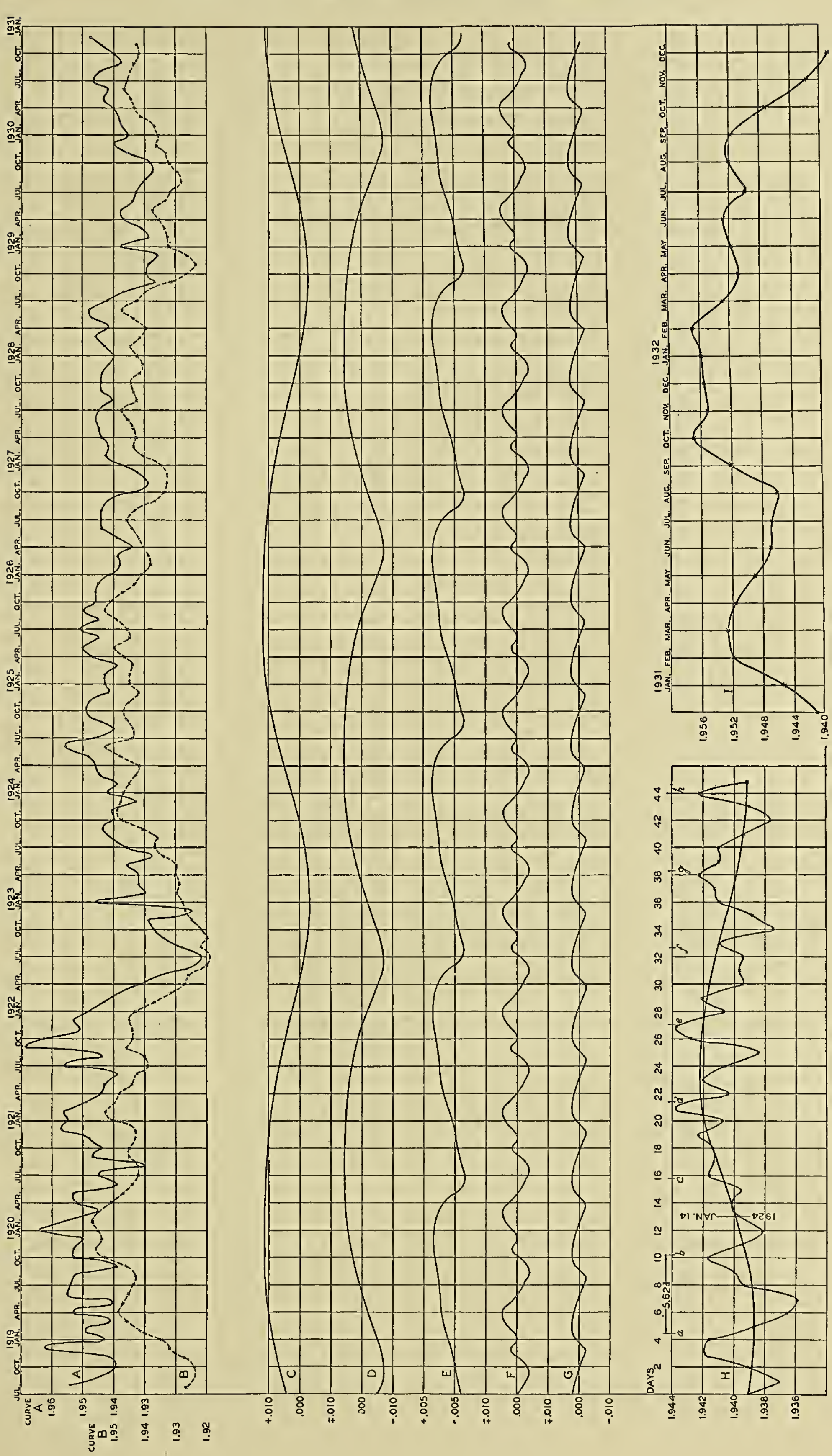

Fig. 28.—Periodicities in solar radiation

feel better satisfied, however, this time, because there is nothing arbitrary about my present analysis. It does not assume periods not indicated by the observations as does the ordinary method of harmonic analysis, which deals with submultiples of some arbitrarily assumed period.

TABLE 39.—*Ten-day solar-constant values, 1918–1930* [1]

Decade	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Jan. 1	--------	1.943	1.968	1.956	1.924	1.946	1.937	1.945	1.944	1.939	1.941	1.925	1.938
2	--------	1.948	1.967	1.953	1.946	--------	1.943	1.939	1.943	1.938	1.931	1.941	1.937
3	--------	1.938	1.959	--------	1.952	--------	1.944	1.947	1.933	1.931	1.942	1.939	1.929
Feb. 1	--------	1.962	1.958	--------	1.911	1.934	1.938	--------	1.938	1.936	1.947	1.937	1.933
2	--------	1.951	1.954	1.952	1.947	1.951	1.943	1.951	1.939	1.946	1.941	1.925	1.939
3	--------	1.930	1.956	1.958	1.948	1.923	1.938	1.938	1.929	--------	1.934	1.925	1.942
Mar. 1	--------	1.950	1.959	1.954	1.949	1.929	1.947	1.941	1.941	--------	1.950	1.932	1.940
2	--------	1.942	1.948	1.940	1.939	1.936	1.944	1.936	1.948	1.944	1.945	1.931	1.937
3	--------	1.931	1.932	--------	1.932	1.931	1.942	1.941	1.932	1.941	1.945	1.932	1.941
Apr. 1	--------	1.943	1.948	1.951	1.930	1.934	1.942	1.945	1.927	1.941	1.946	1.932	1.941
2	--------	1.957	1.956	1.941	1.937	1.928	1.948	1.950	1.937	1.945	1.940	1.942	1.938
3	--------	1.961	1.952	1.934	1.925	1.934	1.947	1.946	1.939	1.945	1.940	1.938	1.941
May 1	--------	1.953	1.950	1.946	1.924	1.934	1.944	1.946	1.937	1.947	1.943	1.936	1.945
2	--------	1.921	1.961	1.939	1.925	1.935	1.948	1.950	1.938	1.944	1.951	1.941	1.948
3	--------	1.945	1.950	1.941	--------	1.937	1.950	1.954	1.942	1.944	1.949	1.937	1.942
June 1	--------	1.957	1.943	1.933	1.910	1.918	1.957	1.943	1.939	1.950	1.947	1.938	1.949
2	--------	1.938	1.934	1.936	1.913	1.934	1.956	1.943	1.946	1.943	1.948	1.932	1.944
3	--------	1.962	1.938	1.945	1.920	1.933	1.953	1.948	1.945	1.945	1.951	1.932	1.941
July 1	--------	1.951	1.945	1.960	1.904	1.934	1.946	1.952	1.942	1.949	1.943	1.935	1.945
2	--------	1.961	1.940	1.957	1.913	1.928	1.951	1.954	1.949	1.942	1.942	1.931	1.949
3	1.921	1.950	1.951	1.953	1.918	1.944	1.942	1.947	1.944	1.946	1.940	1.935	1.947
Aug. 1	1.955	1.961	1.930	1.944	1.919	1.942	1.950	1.949	1.945	1.942	1.943	1.931	1.946
2	1.945	1.942	1.927	--------	1.916	1.940	1.940	1.941	1.942	1.941	1.937	1.932	1.947
3	1.959	1.955	1.932	--------	1.921	1.941	1.933	1.942	1.942	1.941	1.932	1.930	1.943
Sept. 1	1.942	1.938	1.951	--------	--------	1.945	1.941	1.956	1.942	1.940	--------	1.926	1.942
2	1.946	1.942	1.944	--------	1.932	1.944	1.950	1.946	1.940	1.942	1.938	1.928	1.929
3	1.944	1.937	1.944	1.969	1.916	1.942	1.946	1.950	1.943	1.950	1.921	1.930	1.939
Oct. 1	1.951	1.947	1.942	1.959	1.926	1.940	1.953	1.942	1.938	1.945	1.930	1.928	1.939
2	1.930	1.949	1.950	1.969	1.929	1.942	1.949	1.949	1.937	1.944	1.935	1.933	1.941
3	1.933	1.960	1.943	1.966	--------	1.938	1.948	1.946	1.929	1.943	1.927	1.926	1.939
Nov. 1	1.928	1.958	1.951	1.953	1.929	1.934	1.948	1.944	1.931	1.945	1.924	1.932	1.942
2	1.945	1.951	1.946	1.949	1.935	1.944	1.951	1.948	1.926	1.943	1.932	1.936	1.943
3	1.947	1.948	1.945	1.952	1.920	1.944	1.945	1.944	1.930	1.944	1.930	1.939	1.949
Dec. 1	1.962	1.944	1.957	1.956	1.912	1.942	1.942	1.944	1.935	1.949	1.930	1.941	1.945
2	1.969	1.949	1.957	1.938	1.916	1.942	1.947	1.945	1.931	1.935	1.924	1.939	1.948
3	1.960	1.958	1.956	--------	1.912	1.921	1.939	1.946	1.935	1.939	1.927	1.940	1.951

[1] Chilean results only.

TABLE 40.—*Monthly mean solar-constant values, 1918–1930* [1]

Month	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
January	--------	1.943	1.964	1.955	1.948	1.946	1.942	1.943	1.941	1.938	1.940	1.938	1.936
February	--------	1.949	1.956	1.956	1.943	1.930	1.939	1.943	1.938	1.943	1.943	1.929	1.938
March	--------	1.941	1.945	1.949	1.938	1.932	1.945	1.939	1.939	1.942	1.946	1.931	1.939
April	--------	1.953	1.952	1.944	1.931	1.932	1.946	1.947	1.934	1.944	1.942	1.937	1.940
May	--------	1.940	1.953	1.943	1.925	1.936	1.948	1.950	1.939	1.945	1.947	1.938	1.944
June	--------	1.955	1.939	1.939	1.914	1.928	1.955	1.945	1.944	1.946	1.948	1.934	1.943
July	1.921	1.954	1.945	1.956	1.912	1.936	1.946	1.951	1.944	1.945	1.942	1.933	1.947
August	1.954	1.953	1.930	1.944	1.918	1.941	1.940	1.945	1.944	1.941	1.937	1.931	1.945
September	1.944	1.939	1.947	1.969	1.924	1.944	1.946	1.950	1.942	1.944	1.927	1.928	1.937
October	1.939	1.953	1.944	1.962	1.927	1.940	1.949	1.946	1.934	1.944	1.930	1.929	1.940
November	1.941	1 953	1.948	1.951	1.929	1.941	1.948	1.946	1.929	1.944	1.929	1.936	1.944
December	1.962	1.950	1.957	1.953	1.915	1.933	1.942	1.945	1.932	1.942	1.926	1.940	1.947
Yearly Mean	--------	1.949	1.948	1.952	1.927	1.937	1.946	1.946	1.938	1.943	1.938	1.934	1.942

[1] Chilean results only.

I propose soon to apply a similar method to the individual daily observations, in the hope of discovering shorter periodicities. Thus far I have not gone very far in this line, and will reserve it for a later paper. At present, I will only mention that in the year 1924 there appeared to be continuing periodicities of 45 days and of the eighth part thereof, 5.6 days. These are illustrated in curve H of Figure 28. Other periodicities seemed to hold from 2 to 4 months and then disappear.

So far, I have disclosed in solar radiation continuing periods of approximately ½ and ⅕ of the 11¼-year sun-spot cycle, and of 1/16, 1/36, and 1/50 of the Brückner cycle of 33 years. Besides these there were periodicities approximating 45 and 5.6 days in the year 1924, of which it is uncertain whether they belong to these families, though they approximate to 1/90 and 1/720 of the 11¼-year cycle.

In addition to the periodicities just disclosed, we have reason to suppose that there are numerous others of shorter intervals lying between 3 and 120 days which have persisted through a number of cycles each, but have not been permanent. We defer the search for these until the completion of a special instrument which we are preparing. In constructing it we are aided by a grant from the Research Corporation of New York. This instrument is designed to accomplish almost wholly mechanically the same sort of operations as those of which we have just given computed examples.

7. WEATHER PERIODICITIES ASSOCIATED WITH SOLAR VARIATION

The following pages are a further quotation from the paper above cited.

If, as suggested by the title, weather is governed by solar variation, and if, as has just been shown, the solar variation from 1918 to 1930 comprises five definite continuing periodicities, we should expect to find these same periodicities in the weather.

For data to investigate this point, I took from World Weather Records [7] the Washington monthly mean temperatures from 1918 to 1923. I supplemented them to 1930 by taking monthly mean values of "Max." plus "Min.," as given in the Climatological Data.[8] In some previous work I had prepared a plot of the average yearly march of Washington mean temperatures. From this smoothed curve I took values corresponding to the 15th day of each month, and subtracted from my monthly mean data. Thus I obtained the temperature-departures which constitute weather, as freed from the average march of events which constitutes climate. These results are plotted in curve A of Figure 29 and given in column 9 of Table 41.

I then analyzed these temperature-departure data in the manner already explained regarding the solar data. I employed in my analysis the same periods of 68, 45, 25, 11, and 8 months used in the solar work. These were found to represent to a suprisingly close approximation the variation of Washington temperature-departures since 1918. The agreement with observed data was somewhat improved by adding a sixth period of 18 months. These six periodicities are shown graphically in curves C, D, E, F, G, H of Figure 29, and their summation in curve B. The actual data from which these curves are plotted are given in columns 1 to 8 of Table 41.

The reader, I think, will agree with me that the similarity between curves A and B of Figure 29 is both close and significant. Not only are the main trends of the original observations fairly well reproduced in the periodic summation, but many of the details also. Discrepancies, indeed, occur at several times, and unfortunately a principal one is found in 1930. One, therefore, hesitates to predict that the temperature departures of 1931 and following years will be defined by the same six periodicities without modifications of amplitudes or phases. Nevertheless the discrepancy of 1930 is not much more pronounced than several preceding ones, after which fair agreements returned.

[7] Smithsonian Miscellaneous Collections, vol. 79, 1927.
[8] Issued monthly by the United States Weather Bureau, Washington, D. C.

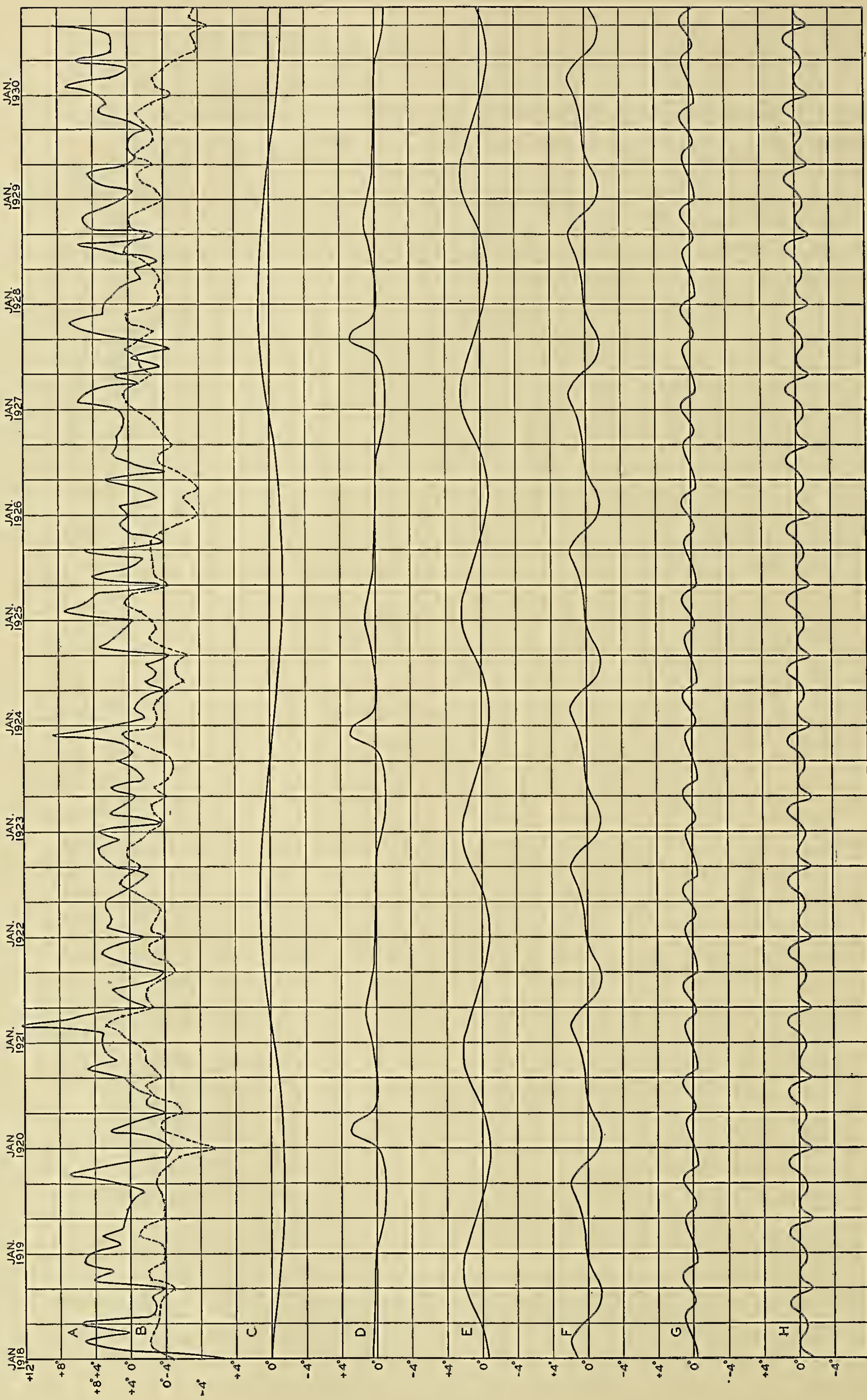

FIGURE 29.—Periodicities in Washington mean monthly temperatures

Table 41.—*Periodic analysis of Washington temperature departures*

	Periodicities Degrees×10 Fahr.						Sum	Original data
	68 m.	45 m.	25 m.	18 m.	11 m.	8 m.	°	°
1918								
January	1	5	−7	14	−4	−16	−0.7	−9.7
February	0	4	−5	19	−2	−3	1.3	0.8
March	−1	3	−3	21	0	−1	1.9	5.1
April	−2	3	−1	16	5	−7	1.4	0.2
May	−3	3	3	7	8	−8	1.0	5.5
June	−4	2	8	−4	10	−3	0.9	−2.7
July	−5	2	13	−12	0	10	0.8	−2.9
August	−6	2	17	−14	−2	6	0.3	2.5
September	−7	2	21	−14	5	−16	−0.9	−4.0
October	−8	2	23	−9	12	−3	1.7	4.1
November	−9	1	23	−4	10	−1	2.0	2.0
December	−10	1	23	0	−4	−7	0.3	5.2
1919								
January	−11	0	21	2	−2	−8	0.2	4.5
February	−12	−1	17	3	0	−3	0.4	1.2
March	−13	−3	14	4	5	10	3.0	3.1
April	−14	−6	11	5	8	6	2.4	0.8
May	−14	−9	7	7	10	−16	0.2	0.5
June	−15	−10	5	10	0	−3	0.2	0.4
July	−15	−10	2	14	−2	−1	0.3	−0.1
August	−16	−11	0	19	5	−7	0.6	−1.5
September	−15	−11	−3	21	12	−8	1.1	1.2
October	−15	−10	−5	16	10	−3	0.8	6.8
November	−15	−9	−7	7	−4	10	−0.3	2.5
December	−14	−7	−8	−4	−2	6	−1.5	−4.2
1920								
January	−14	−3	−9	−12	0	−16	−5.4	−4.7
February	−13	8	−7	−14	5	−3	−2.4	−3.3
March	−13	29	−5	−14	8	−1	0.4	2.2
April	−13	25	−3	−9	10	−7	0.3	−0.4
May	−12	7	−1	−4	0	−8	−1.8	−3.9
June	−12	1	3	0	−2	−3	−1.3	−1.9
July	−11	0	8	2	5	10	1.4	−2.3
August	−10	0	13	3	12	6	2.4	−0.3
September	−9	0	17	4	10	−16	0.6	0.6
October	−8	1	21	5	−4	−3	1.2	4.8
November	−7	2	23	7	−2	−1	2.2	1.6
December	−6	3	23	10	0	−7	2.3	2.9
1921								
January	−4	5	23	14	5	−8	3.5	3.2
February	−3	8	21	19	8	−3	5.0	3.0
March	−1	10	17	21	10	10	6.7	12.2
April	0	12	14	16	0	6	4.8	5.8
May	2	13	11	7	−2	−16	1.5	−1.8
June	4	13	7	−4	5	−3	2.2	0.7
July	6	11	5	−12	12	−1	2.1	2.0
August	7	9	2	−14	10	−7	0.7	−2.5
September	8	7	0	−14	−4	−8	−1.1	−3.8
October	9	5	−3	−9	−2	−3	−0.3	0.6
November	10	4	−5	−4	0	10	1.5	3.2
December	11	3	−7	0	5	6	1.8	1.5
1922								
January	12	3	−8	2	8	−16	0.1	−1.4
February	12	3	−9	3	10	−3	1.6	2.6
March	12	2	−7	4	0	−1	1.0	2.1
April	13	2	−5	5	−2	−7	0.6	2.6
May	13	2	−3	7	5	−8	1.6	2.7
June	13	2	−1	10	12	−3	3.3	1.0
July	12	2	3	14	10	10	5.1	−0.7
August	12	1	8	19	−4	6	4.2	−2.0
September	12	1	13	21	−2	−16	2.9	1.7
October	11	0	17	16	0	−3	4.1	3.0
November	11	−1	21	7	5	−1	4.2	3.6
December	10	−3	23	−4	8	−7	2.7	1.2

TABLE 41.—*Periodic analysis of Washington temperature departures*—Continued

	Periodicities Degrees×10 Fahr.						Sum	Original data
	68 m.	45 m.	25 m.	18 m.	11 m.	8 m.	°	°
1923								
January	9	−6	23	−12	10	−8	1.6	3.4
February	8	−9	23	−14	0	−3	0.5	−3.4
March	7	−10	21	−14	−2	10	1.2	2.1
April	6	−10	17	−9	5	6	1.5	0.6
May	5	−11	14	−4	12	−16	0.0	−0.7
June	4	−11	11	0	10	−3	1.1	2.1
July	3	−10	7	2	−4	−1	−0.3	−1.6
August	2	−9	5	3	−2	−7	−0.8	−0.7
September	1	−7	2	4	0	−8	−0.8	1.4
October	0	−3	0	5	5	−3	0.4	−0.3
November	−1	8	−3	7	8	10	2.9	0.8
December	−2	29	−5	10	10	6	4.8	8.6
1924								
January	−3	25	−7	14	0	−16	1.3	1.8
February	−4	7	−8	19	−2	−3	0.9	−1.7
March	−5	1	−9	21	5	−1	1.2	−0.6
April	−6	0	−7	16	12	−7	0.8	−1.2
May	−7	0	−5	7	10	−8	−0.3	−3.9
June	−8	0	−3	−4	−4	−3	−2.2	−1.9
July	−9	1	−1	−12	−2	10	−1.4	−3.0
August	−10	2	3	−14	0	6	−1.3	−2.0
September	−11	3	8	−14	5	−16	−2.5	−4.4
October	−12	5	13	−9	8	−3	0.2	3.3
November	−13	8	17	−4	10	−1	1.7	1.7
December	−14	10	21	0	0	−7	1.0	0.6
1925								
January	−14	12	23	2	−2	−8	1.3	−0.4
February	−15	13	23	3	5	−3	2.6	7.3
March	−15	11	23	4	12	10	4.5	4.9
April	−16	9	21	5	10	6	3.5	3.8
May	−15	7	17	7	−4	−16	−0.4	−3.4
June	−15	5	14	10	−2	−3	0.9	4.2
July	−15	4	11	14	0	−1	1.3	0.1
August	−14	3	7	19	5	−7	1.3	−1.6
September	−14	3	5	21	8	−8	1.5	5.0
October	−13	3	2	16	10	−3	1.5	−3.9
November	−13	2	0	7	0	10	0.6	−0.1
December	−13	2	−3	−4	−2	6	−1.4	1.0
1926								
January	−12	2	−5	−12	5	−16	−1.4	0.1
February	−12	2	−7	−14	12	−3	−2.2	1.0
March	−11	2	−8	−14	10	−1	−2.2	−3.2
April	−10	1	−9	−9	−4	−7	−3.8	−1.2
May	−9	1	−7	−4	−2	−8	−2.9	2.5
June	−8	0	−5	0	0	−3	−1.6	−4.1
July	−7	−1	−3	2	5	10	0.6	−0.2
August	−6	−3	−1	3	8	6	0.7	1.8
September	−4	−6	3	4	10	−16	−0.9	1.3
October	−3	−9	8	5	0	−3	−0.2	1.3
November	−1	−10	13	7	−2	−1	0.6	0.7
December	0	−10	17	10	5	−7	1.5	0.4
1927								
January	2	−11	21	14	12	−8	3.0	1.1
February	4	−11	23	19	10	−3	3.2	5.7
March	6	−10	23	21	−4	10	4.6	4.7
April	7	−9	23	16	−2	6	4.1	−1.2
May	8	−7	21	7	0	−16	1.3	1.5
June	9	−3	17	−4	5	−3	2.1	−3.5
July	10	8	14	−12	8	−1	2.7	−0.4
August	11	29	11	−14	10	−7	4.0	−4.7
September	12	25	7	−14	0	−8	2.2	−0.8
October	12	7	5	−9	−2	−3	1.0	4.4
November	12	1	2	−4	5	10	2.6	6.6
December	13	0	0	0	12	6	3.1	2.9

TABLE 41.—*Periodic analysis of Washington temperature departures*—Continued

	Periodicities Degrees×10 Fahr.						Sum	Original data
	68 m.	45 m.	25 m.	18 m.	11 m.	8 m.	°	°
1928								
January	13	0	−3	2	10	−16	0.6	2.8
February	13	0	−5	3	−4	−3	0.4	1.9
March	12	1	−7	4	−2	−1	0.7	0.9
April	12	2	−8	5	0	−7	0.4	−1.4
May	12	3	−9	7	5	−8	1.0	−0.8
June	11	5	−7	10	8	−3	2.4	−3.3
July	11	8	−5	14	10	10	4.8	1.4
August	10	10	−3	19	0	6	4.2	5.7
September	9	12	−1	21	−2	−16	2.3	−2.9
October	8	13	3	16	5	−3	4.2	4.6
November	7	11	8	7	12	−1	4.4	5.1
December	6	9	13	−4	10	−7	2.7	3.1
1929								
January	5	7	17	−12	−4	−8	0.5	1.2
February	4	5	21	−14	−2	−3	1.1	−0.5
March	3	4	23	−14	0	10	2.6	3.7
April	2	3	23	−9	5	6	3.0	4.5
May	1	3	23	−4	8	−16	1.5	0.4
June	0	3	21	0	10	−3	3.1	−1.0
July	−1	2	17	2	0	−1	1.9	0.0
August	−2	2	14	3	−2	−7	0.8	−0.2
September	−3	2	11	4	5	−8	1.1	−2.0
October	−4	2	7	5	12	−3	1.9	−0.4
November	−5	2	5	7	10	10	2.9	3.3
December	−6	1	2	10	−4	6	0.9	2.5
1930								
January	−7	1	0	14	−2	−16	−1.0	3.5
February	−8	0	−3	19	0	−3	0.5	6.9
March	−9	−1	−5	21	5	−1	1.0	2.0
April	−10	−3	−7	16	8	−7	−0.3	0.0
May	−11	−6	−8	7	10	−8	−1.6	5.8
June	−12	−9	−9	−4	0	−3	−3.7	1.9
July	−13	−10	−7	−12	−2	10	−3.4	1.9
August	−14	−10	−5	−14	5	6	−3.2	2.1
September	−14	−11	−3	−14	12	−16	−4.8	8.3
October	−15	−11	−1	−9	10	−3	−2.9	
November	−15	−10	3	−4	−4	−1	−3.1	
December	−15	−9	8	0	−2	−7	−2.5	

It may be objected that the five solar periodicities alone were insufficient to give the best representation, without adding a sixth of 18 months not found conspicuously in solar variation. Is not this last periodicity possibly of terrestrial origin? May it not be due to some peculiarity of Washington surroundings which lends a predisposition to a periodicity of 18 months? For analogy, consider an automobile on a dirt road. It vibrates as the wheels strike the irregularities of the road, in a manner depending on these outside interferences. But at some special speeds, there are sometimes encountered "sympathetic" vibrations due to the make-up of the car itself.

After all, the contribution of the 18-month periodicity to the fit between curves A and B is a minor feature. Is not their surprising agreement, which would still be striking if the 18-month curve F were omitted, significant because related to solar phenomena? Is it not indeed of promising import from the standpoint of long-range weather forecasting?

Since the paper just quoted was published some criticisms have been received in personal correspondence. Among them are the following:

1. The representation of the solar variation since 1918 as the sum of five regular periodicities is not remarkable. Any curve can be represented as the sum of regular periodicities if a sufficient number of them is used.

2. The representation of the Washington temperatures as the sum of six regular periodicities is unsuccessful. The average deviation is very little reduced.

Quite as much reduction of it could be reached by appropriately altering the climatic curve of yearly march of temperature.

We suggest, in reply, that a test of the matter would be a successful forecast. As already stated, about a third of the curve B in Figure 28 is practically a true forecast, because the five periodicities employed were determined almost wholly from the data of 1924 to 1930. During the months January to May 15 of 1931, which are forecasted in curve I of Figure 28, the following results have appeared. Though averaging nearly 0.4 per cent lower than predicted, they are still above normal as expected. It will be interesting to note later results.

Table 42.—*Predicted and observed solar-constant march, 1931*

Month	Decade	Observed	Number	Predicted	Pred.—Obs.	Second mean minus (P—O)
January	1	1. 943	2	1. 944	0. 001*	0. 006
	2	1. 944	7	1. 945	0. 001	. 006
	3	-------	------	1. 947	----------	------------
February	1	1. 942	2	1. 951	0. 009*	—. 002
	2	1. 945	8	1. 952	0. 007	. 000
	3	1. 941	6	1. 952	0. 011	—. 004
March	1	1. 932	4	1. 953	0. 021*	—. 014
	2	1. 945	10	1. 953	0. 008	—. 001
	3	1. 948	11	1. 952	0. 004	. 003
April	1	1. 948	8	1. 952	0. 004	. 003
	2	1. 948	7	1. 952	0. 004	. 003
	3	1. 938	7	1. 951	0. 013	—. 006
May	1	1. 936	8	1. 950	0. 014	—. 007
	2	1. 945	5	1. 949	0. 004	. 003
Mean	------	---------	------	---------	0. 0078	. 0045

Mean, omitting starred values which rest on less than 5 values, 0.0070.

We further suggest, in reply to the second criticism, that it is not to be expected by the use of six periodicities, of which the shortest is eight months, to reduce very greatly the average deviation of monthly mean values. Other terms of shorter periods would be required for that. A fair comparison of curves A and B of Figure 29 must regard only the longer trends. For convenience, therefore, we give in Figure 30 plots of 5-month consecutive means [9] from curves A and B of Figure 29. Regarding Figure 30, it can no longer be claimed that the resemblance fails at Washington, except in rare instances in the earlier years, though it evidently fails in the year 1929 and 1930. However, it is further suggested that the year 1930 was very exceptional. Its prolonged drought, which extended to Washington, was doubtless the product of

[9] That is: $\frac{a+b+c+d+e}{5}, \frac{b+c+d+e+f}{5}$, etc. This method of smoothing has been applied to both curves A and B of Figure 28 and to corresponding curves computed for Williston, N. D. The results appear in curves A, B, C, D, Figure 29.

causes which conspire together in such severity only perhaps about once in a century. It is not surprising if this extraordinary occurrence should really have led to a discordance.

In further support of the general proposition that periodicities of 68, 45, 25, 11, and 8 months are significant in the weather of 1918 to 1930, we give in Figure 30 curves C and D for Williston, N. D., the result of a treatment like that which produced in Figure 30 curves A and B for Washington.

The departures from monthly mean values for Williston were obtained as follows: From the annual summaries of climatology published by the United States Weather Bureau, we took out the values called monthly mean temperatures. We did not use their values called departures for two reasons. First, we wished to remove altogether the average annual march of temperatures as it existed in the years 1918 to 1930. We therefore computed the mean values over this term of years for all months from the individual monthly means just referred to. But in the second place, we found that the monthly departures as printed in the annual summaries are not homogeneous. A change of normals was made by the Weather Bureau in 1923, so that the printed departures before that date are not directly comparable to those following. Our departures were therefore computed from normals obtained from the mean temperatures of 1918 to 1930 alone.

The component periodicities of 68, 45, 25, and 11 months for Williston are shown in curves E, F, G, and I of Figure 30. That of 68 months is not computed, but is drawn to represent with best fit the average march of the residuals which remained after all the other periodicities had been removed from the Williston monthly mean departures. We suggest that the fact that it is of 68 months period, and not some other sort of a curve, perhaps nonperiodic altogether, tends to strengthen the hypothesis that solar change is the operating cause. We remind readers that the periods 68 and 45 months are not only components of curve B of Figure 28, but are respectively the half and the third of the 11¼-year sun-spot cycle.

We had omitted to compute the temperature periodicity of 8 months for Williston. It is but a minor component in Washington temperatures, as shown by Figure 29. We thought it might be ignored at Williston. But it refuses to be ignored. For as curve G, Figure 30, shows, the 8-month periodicity can not be denied. It forces itself into the picture by producing the trisecting scallops so plainly superposed on the march of the 25-month periodicity.

Curve H shows that the extra periodicity of 18 months, not found in solar variation, is fully as important in Williston temperatures of 1918 to 1930 as it is for Washington. We are therefore led to revise our suggestion that it is due to terrestrial conditions surrounding Washington, and now suggest that it is of some terrestrial causation widely operative.

Just as the computation of the 25-month periodicity revealed the existence of an 8-month periodicity in Williston temperatures, the preliminary computations of the several longer periodicities indicated plainly that periodicities of 3, 3.6, and 5 months were present. Although these are of minor influence both on account of their brevity and their smaller magnitudes, we preferred to compute them successively and to remove them from the original data before proceeding with the definitive

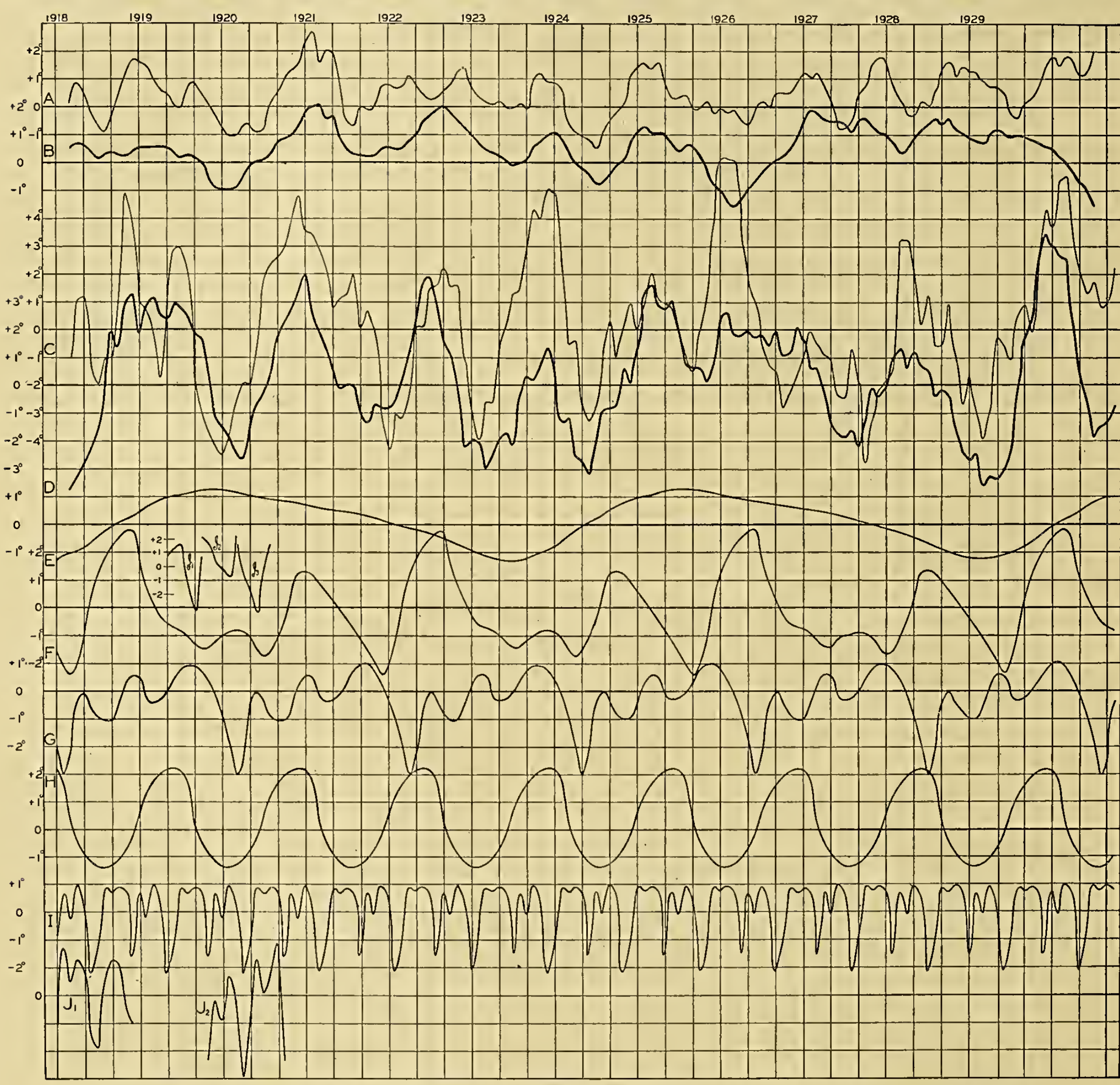

Figure 30.—Washington and Williston temperatures associated with solar periodicities. Five-month consecutive means

computations of the periodicities of 11, 18, 25, and 45 months. We are not sure whether the periodicities of 3, 3.6, and 5 months are of solar or terrestrial causation.

In computing all the periodicities of 25 months and briefer, we considered the data sufficiently numerous to be divided into two, three, or more successive divisions. We were gratified to find in this way that these periodicities were continuing through the whole interval of 13 years, with minima not shifted as between the early and later years. In illustration of this result, see curves J_1 and J_2, and curves δ_1, δ_2 and δ_3 of Figure 30. The curves J_1 and J_2 represent the 11-month periodicity derived from the first and the second halves of the data, respectively. Compare each with the general mean shown just above in curve I. The curves δ_1, δ_2 and δ_3, represent the 5-month periodicity computed from the first, middle, and last thirds of the data, respectively.

As for the general result of all this labor, it seems to us far more striking and convincing of the reality of solar control of temperature departures at Williston than at Washington. Yet the juxtaposition of curves A, B, C, and D in Figure 30 produces a cumulatively impressive effect upon the mind, whatever may be our view as to the reality of solar influences. In general the same great mountains and valleys occurred in the marches of temperature at Washington and Williston, but on a much grander scale in the freer stretches of Williston surroundings than as toned down by the forested and mountain-guarded country about Washington. Yet sharp differences are also apparent. We are pleased to find that the years 1929 and 1930 prove well represented as to the general form of the departures as predicted by periodicities at Williston though so aberrant at Washington. The exceptional drought year, 1930, follows an exceptionally great range of departures at Williston in 1929. Possibly this is of important significance.

As in Washington, so also at Williston, the average of the residuals of the unsmoothed monthly values, remaining after removing all the periodicities, is but little reduced from what it is for the original data. But this, we submit, is only what is to be expected. The individual months are affected separately by briefly operative stimuli, both of periodic and accidental sorts. There are not included in the sweeps of the long-range periodicities of from 8 to 68 months with which we are now dealing.

8. CORRELATION OF LONG-PERIOD CHANGES OF SOLAR RADIATION WITH WEATHER CHANGES

If the periodic solar changes indicated under Section 6 really cause such weather changes as are indicated under section 7, what effect on the weather should be expected to follow a notable change in solar radiation, such as occurred, for instance, in 1922? Should we expect thereafter, admitting a certain amount of delay, to find a similarly outstanding and definite temperature response?

To clarify our ideas on this point, Figure 31 shows juxtaposed, in what appear to be the proper time relations, the five periodicities of 68, 45, 25, 11, and 8 months, respectively, found both in the solar radiation and in the temperature of Washington since 1918. There may, indeed, be some question whether the time relations are correct. We can not tell from theoretical considerations whether a rise in solar radiation produces a rise or a fall in Washington temperature. Yet in the cases of both the 68-month and the 45-month periodicities, the solar period and the temperature period both show a longer nterval of positive than of negative departures. This has led us to make that particular association shown in Figure 31, in which the longer excursions from the zero of departures have been regarded as corresponding each to each. This sets the precedent for regarding increasing solar radiation as a forerunner of increasing temperature departures at Washington. We have followed it in the other three cases. But whether this or another interpretation is the true one, the point which we are about to make will still hold.

The timing of the periodicity curves of solar and temperature data at Washington is such that whatever association is made between them there will be found

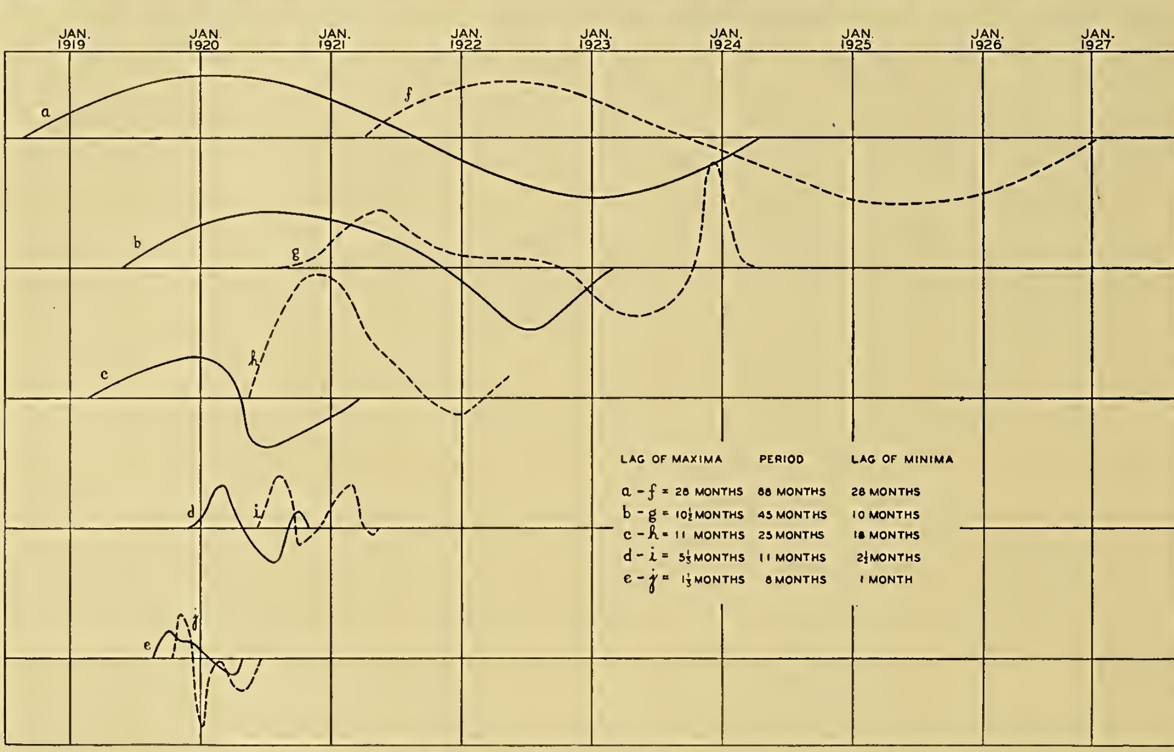

FIGURE 31.—Apparent lags of response of Washington temperatures to solar periodicities

in any case unequal intervals of lag between the solar changes and the excursions of temperature assumed to be their effects. Therefore a marked feature of solar change due to the concurrent superposition of effects of nearly all of the five permanent solar periodicities, such as occurred in the year 1922, can not produce an outstanding well-marked response in the temperature of Washington. Through unequal lagging of the temperature effects corresponding to the five component periodicities of the solar change, its influence on the weather is spread over several years in such a way as to cause nothing so uniquely outstanding in any of them. Hence, it is not an argument against the reality of solar domination of weather that its influence has not hitherto been apparent. For it is only by regarding the influences of periodic solar changes separately, and with a knowledge of their time lags, that progress in studying their weather effects can be made. Hitherto these data were not available.

9. IRREGULAR SOLAR VARIATIONS OF SHORT INTERVAL AFFECTING WEATHER

Again quoting from the paper above cited:

Figure 23 shows the daily observations of the solar constant of radiation made at Montezuma, Chile, since 1924. Full and dotted curves in Figure 23 mark all the well-supported sequences of rising and of falling solar radiation. They occur in short intervals, averaging 5 days. All of those selected exceed 0.4 per cent in range, averaging 0.8 per cent. These rising and falling sequences are 111 and 106 in number, respectively. Many are lost because of unfavorable observing conditions

TABLE 43.—*Washington mean temperatures and temperature departures*

[Ascending solar sequences reach their culmination on zero day]

Month of March					Zero Day					5th Day					10th Day					15th Day					20th Day
1924	29	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	34.5	42.0	37.5	41.0	47.5	50.0	41.5	42.0	37.5	38.5	36.0	34.5	40.5	39.0	32.5	32.0	36.0	40.5	47.5	43.5	37.5	34.5	41.5	46.0	47.0
	0.0	7.5	3.0	6.5	13.0	15.5	7.0	7.5	3.0	4.0	1.5	0.0	6.0	4.5	−2.0	−2.5	1.5	6.0	13.0	9.0	3.0	0.0	7.0	11.5	12.5
1924	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2
	38.5	36.0	34.5	40.5	39.0	32.5	32 0	36.0	40.5	47.5	43.5	37.5	34.5	41.5	46.0	47.0	44.5	46.0	44.0	56.5	61.5	60.5	43.0	34.0	35.5
	0.0	−2.5	−4.0	+2.0	+0.5	−6.0	−6.5	−2.5	+2.0	+9.0	+5.0	−1.0	−4.0	+3.0	+7.5	+8.5	+6.0	+7.5	+5.5	+18.0	+23.0	+22.0	+4.5	−4.0	−3.0
1923	29	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	45.5	41.0	37.0	36.0	37.5	33.5	32.0	43.5	43.5	38.5	38.5	38.0	46.0	49.5	50.5	46.0	39.5	37.0	36.5	35.5	38.5	40.5	50.0	56.0	59.5
	0.0	−4.5	−8.5	−9.5	−8.0	−12.0	−13.5	−2.0	−2.0	−7.0	−7.0	−7.5	+0.5	+4.0	+5.0	+0.5	−6.0	−8.5	−9.0	−10.0	−7.0	−5.0	+4.5	+10.5	+14.0
1928	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	33.5	32.0	43.5	43.5	38.5	38.5	38.0	46.0	49.5	50.5	46.0	39.5	37.0	36.5	35.5	38.5	40.5	50.0	56.0	59.5	67.5	65.0	51.5	45.5	48.5
	0.0	−1.5	+10.0	+10.0	+5.0	+5.0	+4.5	+12.5	+16.0	+17.0	+12.5	+6.0	+3.5	+3.0	+2.0	+5.0	+7.0	+16.5	+22.5	+26.0	+34.0	+31.5	+18.0	+12.0	+15.0
1928	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9
	39.5	37.0	36.5	35.5	38.5	40.5	50.0	56.0	59.5	67.5	65.0	51.5	45.5	48.5	46.5	39.5	42.5	46.5	52.0	61.5	70.0	70.5	66.0	55.5	49.0
	0.0	−2.5	−3.0	−4.0	−1.0	+1.0	+10.5	+16.5	+20.0	+28.0	+25.5	+12.0	+6.0	+9.0	+7.0	0.0	+3.0	+7.0	+12.5	+22.0	+30.5	+31.0	+26.0	+16.0	+8.5
1928	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	56.0	59.5	67.5	65.0	51.5	45.5	48.5	46.5	39.5	42.5	46.5	52.0	61.5	70.0	70.5	66.0	55.5	49.0	41.5	38.0	50.5	57.5	64.0	46.5	40.0
	0.0	+3.5	+11.5	+9.0	−4.5	−10.5	−7.5	−9.5	−16.5	−13.5	−9.5	−4.0	+5.5	+14.0	+14.5	+10.0	−0.5	−7.0	−14.5	−18.0	−5.5	+1.5	+8.0	−9.5	−16.0
1929	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13
	56.0	56.0	69.5	68.0	68.5	58.0	65.0	53.5	54.0	48.5	44.5	49.0	63.0	49.0	58.5	67.0	69.0	74.0	77.5	76.0	68.0	50.5	44.0	53.5	56.5
	0.0	0 0	+13.5	+12.0	+12.5	+2.0	+9.0	−2.5	−2.0	−7.5	−11.5	−7.0	+7.0	−7.0	+2.5	+11.0	+13.0	+18.0	+21.5	+20.0	+12.0	−5.5	−12.0	−2.5	+0.5
1930	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6
	53.0	45.0	39.0	48.0	59.6	62.5	50.5	46.5	43.5	31.5	38.5	49.5	56.5	39.5	42.0	44.0	47.5	43.0	53.5	48.0	48.0	40.0	50.0	50.5	51.0
	0.0	−8.0	−14.0	−5.0	+6.0	+9.5	−2.5	−6.5	−9.5	−21.5	−14.5	−3.5	+3.5	−13.5	−11.0	−9.0	−5.5	−10.0	+0.5	−5.0	−5.0	−13.0	−3.0	−2.5	−2.0
1930	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	43.5	31.5	38.5	49.5	56.5	39.5	42.0	44.0	47.5	48.5	43.0	53.5	48.0	40.0	50.0	50.5	51.0	53.5	45.0	46.5	51.5	69.0	65.5	58.5	64.5
	0.0	−12.0	−5.0	+6.0	+13.0	−4.0	−1.5	+0.5	+4.0	+5.0	−0.5	+10.0	+4.5	−3.5	+6.5	+7.0	+7.5	+10.0	+1.5	+3.0	+8.0	+25.5	+22.0	+15.0	+21.0
Means	0.0	−2.22	+0.39	+3.00	+4.06	+0.06	−0.06	+1.56	+1.67	+1.50	+0.17	−0.56	+3.61	+1.50	+3.56	+3.39	+2.89	+4.39	+5.94	+7.22	+10.33	+9.78	+8.39	+5.17	+5.61
Yearly march	−2.40	−2.00	−1.70	−1.40	−1.10	−0.80	−0.40	−0.10	0.30	0.70	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.30	4.70	5.00	5.30	5.70
Corrected means	2.40	−0.22	2.09	4.40	5.16	0.86	0.34	1.66	1.37	0.80	−0.83	−0.74	1.91	−0.50	1.26	0.69	−0.11	1.09	2.24	3.22	6.03	5.08	3.39	−0.13	−0.11

TABLE 44.—*Washington mean temperatures and temperature departures*

[Descending solar sequences reach their culmination on zero day]

Month of March					Zero day					5th day					10th day					15th day					20th day
1924	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	42.0	37.5	38.5	36.0	34.5	40.5	39.0	32.5	32.0	36.0	40.5	47.5	43.5	37.5	34.5	41.5	46.0	47.0	44.5	46.0	44.0	56.5	61.5	60.5	43.0
	−0.0	−4.5	−3.5	−6.0	−7.5	−1.5	−3.0	−9.5	−10.0	−6.0	−1.5	+5.5	+1.5	−4.5	−7.5	−0.5	+4.0	+5.0	+2.5	+4.0	+2.0	+14.5	+19.5	+18.5	+1.0
1925	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7
	57.0	38.5	39.5	45.5	49.5	59.0	48.0	52.0	50.5	43.0	47.0	57.5	58.0	54.0	43.5	37.5	41.0	46.5	46.0	42.5	51.0	52.5	50.5	44.5	49.0
	0.0	−18.5	−17.5	−11.5	−7.5	+2.0	−9.0	−5.0	−6.5	−14.0	−10.0	+0.5	+1.0	−3.0	−13.5	−19.5	−16.0	−10.5	−11.0	−14.5	−16.0	−4.5	−6.5	−12.5	−8.0
1925	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12
	59.0	48.0	52.0	50.5	43.0	47.0	57.5	58.0	54.0	43.5	37.5	41.0	46.5	46.0	42.5	51.0	52.5	50.5	44.5	49.0	54.5	51.5	59.5	59.0	63.0
	0.0	−11.0	−7.0	−8.5	−16.0	−12.0	−1.5	−1.0	−5.0	−15.5	−21.5	−18.0	−2.5	−3.0	−16.5	−8.0	−6.5	−8.5	−14.5	−10.0	−4.5	−7.5	+0.5	0.0	+4.0
1927	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	42.5	47.5	43.5	44.0	43.0	46.0	51.0	44.0	39.0	42.0	39.0	41.0	54.0	49.0	43.5	39.0	45.0	48.5	54.0	52.0	49.5	53.5	63.5	64.5	61.5
	0.0	+5.0	+1.0	+1.5	+0.5	+3.5	+8.5	+1.5	−3.5	−0.5	−3.5	−1.5	+11.5	+6.5	+1.0	−3.5	+2.5	+5.5	+11.5	+9.5	+7.0	+11.0	+21.0	+22.0	+19.0
1928	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	43.5	43.5	38.5	38.5	38.0	46.0	49.5	50.5	46.0	39.5	37.0	36.5	35.5	38.5	40.5	50.0	56.0	59.5	67.5	65.0	51.5	45.5	48.5	46.5	39.5
	0.0	0.0	−5.0	−5.0	−5.5	+2.5	+6.0	+7.0	+2.5	−4.0	−6.5	−7.0	−8.0	−5.0	−3.5	+6.5	+12.5	+16.0	+24.0	+21.5	+8.0	+2.0	+5.0	+3.0	−4.0
1928	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6
	49.5	50.5	46.0	39.5	37.0	36.5	35.5	38.5	40.5	50.0	56.0	59.5	67.5	63.0	51.5	45.5	48.5	46.5	39.5	42.5	46.5	52.0	61.5	70.0	70.5
	0.0	+1.0	−3.5	−10.0	−12.5	−13.0	−14.0	−11.0	−9.0	+0.5	+6.5	+10.0	+18.0	+15.5	+2.0	−4.0	−1.0	−3.0	−10.0	−7.0	−3.0	+2.5	+12.0	+20.5	+21.0
1928	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12
	35.5	38.5	40.5	50.0	56.0	59.5	67.5	65.0	51.5	45.5	48.5	46.5	39.5	42.5	46.5	52.0	61.5	70.0	70.5	66.0	55.5	49.0	41.5	38.0	50.5
	0.0	+3.0	+5.0	+14.5	+20.5	+24.0	+32.0	+29.5	+16.0	+10.0	+13.0	+11.0	+4.0	+7.0	+11.0	+16.5	+26.0	+34.5	+35.0	+30.5	+20.0	+13.5	+6.0	+2.5	+15.0
1928	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	51.5	45.5	48.5	46.5	39.5	42.5	46.5	52.0	61.5	70.0	70.5	66.0	55.5	49.0	41.5	38.0	50.5	57.5	64.0	46.5	40.0	44.0	44.5	65.5	56.0
	0.0	−6.0	−3.0	−5.0	−12.0	−9.0	−5.0	+0.5	+10.0	+18.5	+19.0	+14.5	+4.0	−2.5	−10.0	−13.5	−1.0	+6.0	+12.5	−5.0	−11.5	−7.5	−7.0	+14.0	+4.5
1930	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9
	48.0	59.0	62.5	50.5	46.5	43.5	31.5	38.5	49.5	56.5	39.5	42.0	44.0	47.5	48.5	43.0	53.5	48.0	40.0	50.0	50.5	51.0	53.5	45.0	46.5
	0.0	+11.0	+14.5	+2.5	−1.5	−4.5	−16.5	−9.5	+1.5	+8.5	−8.5	−6.0	−4.0	−0.5	+0.5	−5.0	+5.5	0.0	−8.0	+2.0	+2.5	+3.0	+5.5	−3.0	−1.5
1930	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	56.5	39.5	42.0	44.0	47.5	48.5	43.0	53.5	48.0	40.0	50.0	50.5	51.0	53.5	45.0	46.5	51.5	69.0	65.5	58.5	64.5	56.0	46.0	44.5	56.5
	0.0	−17.0	−14.5	−12.5	−9.0	−7.5	−13.5	−3.0	−8.5	−16.5	−6.5	−6.0	−5.5	−3.0	−11.5	−10.0	−5.0	+12.5	+9.0	+2.0	+8.0	−0.5	−10.5	−12.0	0.0
Means	0.0	−3.70	−3.35	−4.00	−5.05	−1.55	−1.60	−0.05	−1.25	−1.90	−1.95	+0.30	+2.00	+0.75	−4.80	−4.10	+2.10	+5.75	+5.10	+3.30	+1.25	+2.65	+4.55	+5.30	+5.10
Yearly march	−2.40	−2.00	−1.70	−1.40	−1.10	−0.80	−0.40	−0.10	+0.30	+0.70	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.30	4.70	5.00	5.30	5.70
Corrected means	2.40	−1.70	−1.65	−2.60	−3.85	−0.75	−1.20	+0.05	−1.55	−2.60	−2.95	−1.00	0.30	−1.25	−7.10	−6.80	−0.90	2.45	1.40	−0.70	−3.05	−2.05	−0.45	0.0	−0.60

Figure 32A shows average changes in the mean temperature and Figure 32B the barometric pressure at Washington, D. C., associated with these rising and falling sequences of solar

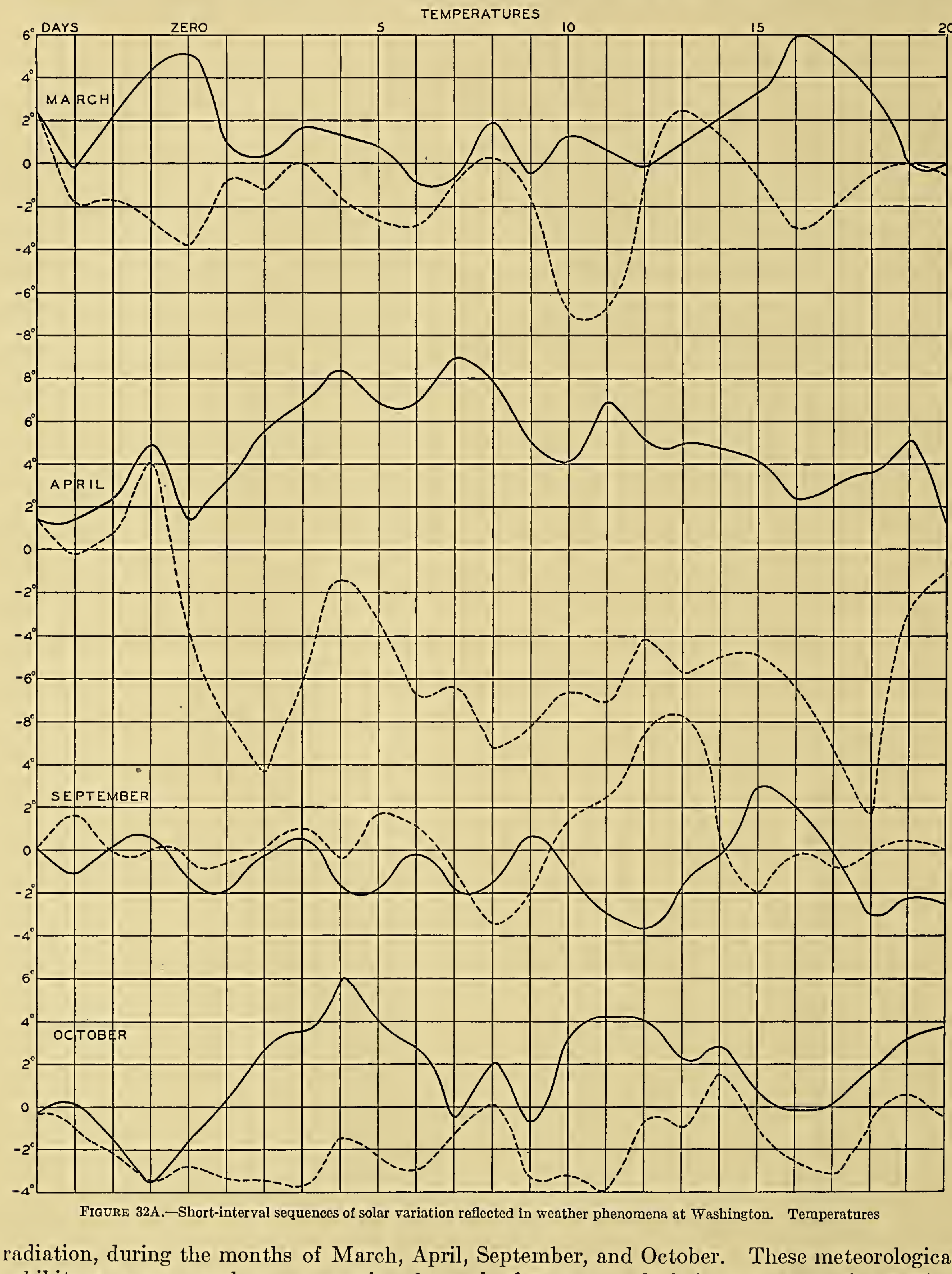

FIGURE 32A.—Short-interval sequences of solar variation reflected in weather phenomena at Washington. Temperatures

radiation, during the months of March, April, September, and October. These meteorological exhibits are average values representing the work of 7 years, and of about 10 cases of each kind in each month.

The method of computing the curves shown in Figure 32A is illustrated in Tables 42 and 43 as regards temperatures of March. The temperatures (which are the mean of maximum and minimum at Washington as published by the U. S. Weather Bureau) are arranged in consecutive

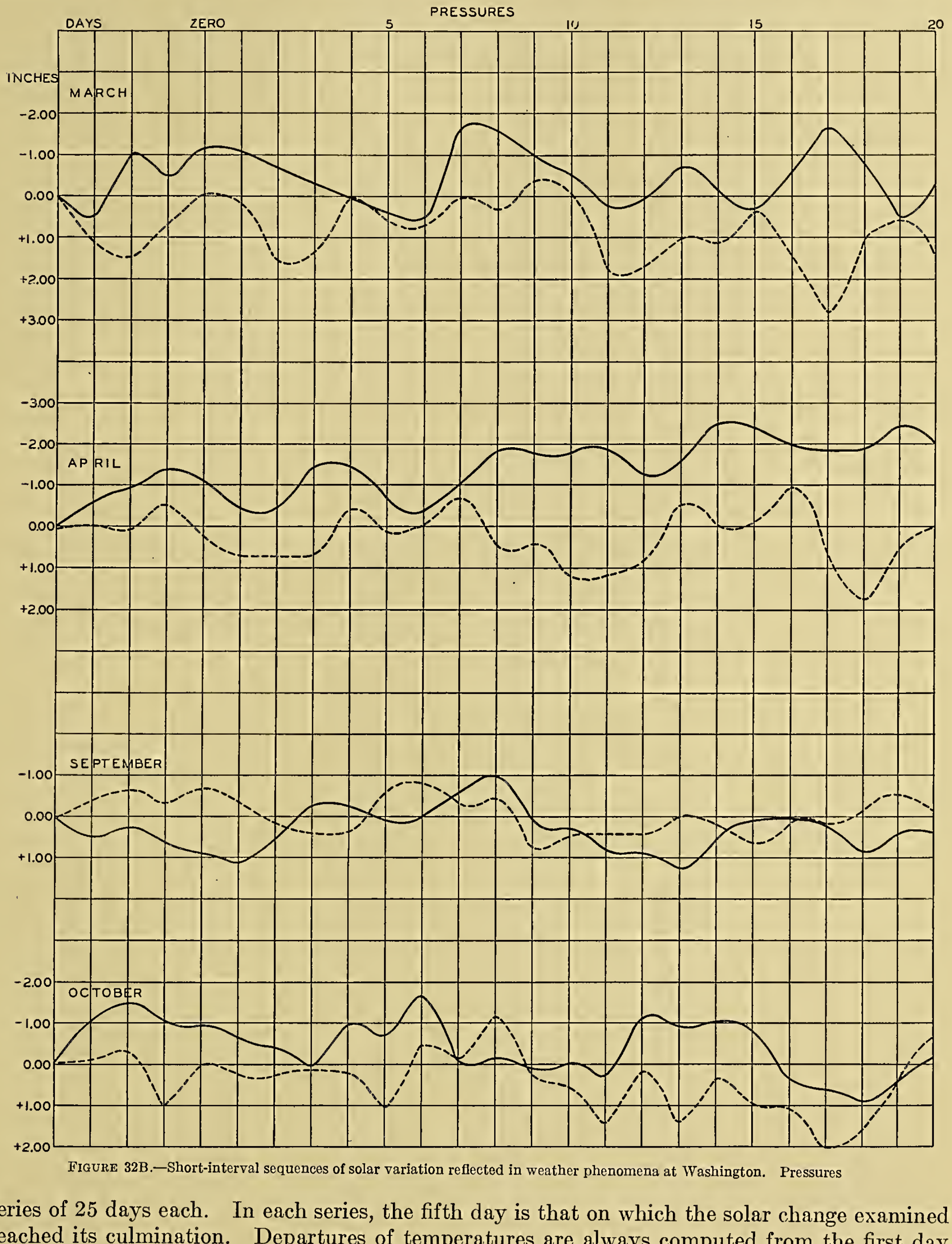

FIGURE 32B.—Short-interval sequences of solar variation reflected in weather phenomena at Washington. Pressures

series of 25 days each. In each series, the fifth day is that on which the solar change examined reached its culmination. Departures of temperatures are always computed from the first day of the series as the base. The mean values of all the departures occurring in March in the years 1924 to 1930 are given at the foot of the table. They are corrected to eliminate the secular rise of temperature which, of course, occurs during any 25-day interval at that season of the year. The final result is plotted in Figure 32A. The reader will see that in all cases there is a marked opposition between curves corresponding to rising and falling solar radiation, respectively.

The constant opposition of the weather effects following opposite solar causes seems to demonstrate a physical connection between the weather of Washington and the changes in the solar constant of radiation as observed in Chile. Average changes of mean temperature of 5° Fahrenheit are found corresponding to solar changes averaging only 0.8 per cent. Hence we may suppose that on many occasions temperature effects caused by solar changes may reach 10°, and sometimes 15° or 20°. *That is to say, major changes in weather are due to short-period changes in the sun.*

By what physical connection are these surprising meteorological results produced by such small solar changes? We must discard at once, I think, the idea that changes of ground temperature, directly produced, communicate the effects to the surface air. For firstly, by Stefan's law, in equilibrium conditions radiation varies as the fourth power of the absolute temperature. Hence a change of 1 per cent in radiation, if acting directly and in equilibrium conditions, should require but one-fourth per cent change in the earth's temperature. Actually the change of temperature observed exceeds 1 per cent, reckoned from the absolute zero. Secondly, in March and some other months, a temperature effect at Washington is found to be nearly simultaneous with the solar change. The solid earth has too large a capacity for heat to follow in temperature thus quickly. Thirdly, large effects occur at Washington 10 or 12 days, and sometimes 16 or 17 days, after the solar cause ceases. Not all of these effects can be direct. Fourthly, in September a reversal of sign is observed.

Admitting that the meteorological effects are produced indirectly, let us recall: Firstly, that from 10 to 25 per cent of the solar radiation is primarily absorbed in the atmosphere itself, which has a very small capacity for heat. Secondly, that the atmosphere circulates in great cyclonic whirls. Thirdly, that the temperature of a station depends greatly on the prevailing wind direction. May it not be that the instantaneous changes of heat absorption in the atmosphere tend to displace centers of cyclones, and thereby to alter the wind direction at stations, thus altering their temperatures?

How shall we explain deferred effects occurring 10 or even 17 days after the culmination of solar sequences? May they not result from atmospheric waves drifting in a southeasterly direction from distant centers of action where primary effects are produced? If so, we must perceive that the average effects shown in Tables 42 and 43 can form no trustworthy basis for forecasting individual cases. For primary and secondary effects, treading on each other's heels, as it were, must often interfere, and either augment or reduce expected weather changes.

In further support of the surprising conclusion that short-interval solar changes averaging 0.8 per cent are competent to produce important weather changes, we give in Figure 33 evidence from the temperatures of Williston, N. D. We employ the same four months, March, April, September, and October, and the same sequences of solar change observed in Chile, and treated in the same way as for Washington. Again we perceive that opposite marches of temperature departures are associated with sequences of solar change of opposite signs. But the effect is generally greater and more convincing in the Williston results. Yet there are interesting differences. The sign of the effect is generally reversed at Williston as compared to Washington. Also the months September and October exchange relations as regards the magnitudes of the effects.

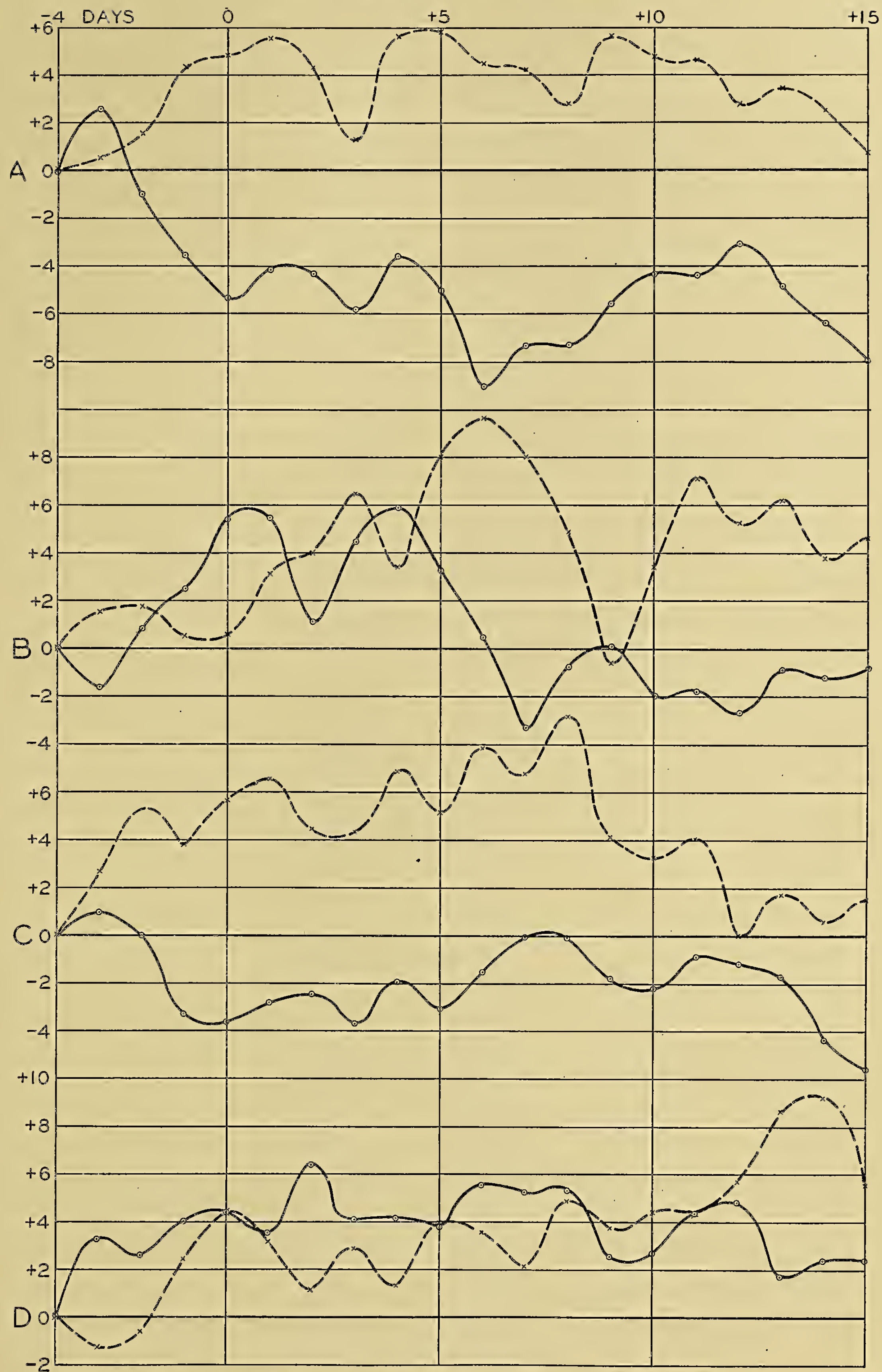

FIGURE 33.—Short-interval sequences of solar variation reflected in temperatures at Williston

We have examined other evidence. We have computed the effects in all months both at Washington and Williston and in addition also at Yuma, Ariz. We give the months here chosen because more data of solar sequences were available so that the results deserved more weight than for other months. We have given Washington and Williston as examples because the effects are larger there than at Yuma, as was to be expected in view of comparisons of other meteorological relations at the three stations. But in general, for all months and for all stations thus far examined we find the same general result. Opposite sequences of solar changes are associated in the average of numerous cases with opposite marches of weather phenomena.

10. THE VALIDITY OF SOLAR-CONSTANT VARIATIONS AND OF THEIR WEATHER INFLUENCES

We believe that readers will hardly question the reality of the solar changes indicated in Figure 26A. Two independent observing stations 5,000 miles apart in opposite hemispheres yield monthly mean values over a period of five years which deviate from the mean curve by an average difference of only 0.08 per cent. They unite simultaneously in showing definite indications of solar change, ranging from 0.2 to 1.2 per cent.

We believe that readers will be inclined also to accept the evidence of five regular periodicities in solar variations, persisting from 1918 to 1930, as shown in Figure 28.

Whether or not meteorologists will recognize a real relationship between Figures 28 and 29, as indicated also by Figure 30, we are not so sure. We presume that a convincing demonstration by long-continued statistically-proved successful long-range forecasting according to these relationships must be awaited. How this can be secured if all who have the means are too skeptical to give it a fair trial is another question.

As regards the validity of short-interval fluctuations of solar radiation such as are indicated in Figure 23, we suppose there will still be many doubters. We hope still to improve our methods and results so much as to bring a thoroughly convincing harmony between distant stations in future years.

Nevertheless, the correlations shown in Section 9, must, we think, deserve consideration. The variations of Montezuma solar-constant values are certainly in correlation with variations of weather in the United States. Either the changes are in the sun and the variation of the sun affects the weather, or else the Montezuma observation and the weather of the opposite hemisphere are both affected by the same atmospheric influences. This seems to us a more improbable explanation than real solar variation.

There is, after all, reason to expect short-interval solar variations. The surface of the sun shows changes to telescopic and spectroheliographic observations. Sun spots form and disappear. Faculae cover large areas with their superbrightness and fade away. The sun rotates on its axis and thereby presents these unequally bright features successively towards the earth. Obviously, short-interval changes in solar radiation must occur. The only question is as to their magnitudes.

In view of the evidence in section 5, *b* of this chapter, the existence of long-interval solar changes cannot longer be doubted. Their physical causes may never be fully understood. Yet a more disturbed sun must surely be a hotter-surfaced sun, considering the sun's fluid nature. This follows for the same reason that stirred coals present hotter surfaces and give out increased radiation. We conceive that similarly long-interval solar changes are caused by general changes in the effective radiating temperature of the sun.

It would be a powerful argument if the weather effects of solar changes could be reduced to a theoretical basis in both quality and quantity. Unfortunately, the complexity of the problem stands as an almost insuperable barrier. The facts, as we accept them, are that long-period changes of solar radiation of the order of 1 per cent produce changes of absolute temperature at continental stations of the temperate zone of about 1 per cent. These effects are attended with time lags, differing in length, and being longer the longer the period of the producing solar change.

Obviously, if the temperature changed as a direct consequence of insolation, we should expect only one-fourth of 1 per cent change of temperature for 1 per cent change of solar radiation. For the condition of equilibrium would be governed by Stefan's law, $R = T^4$, whence $dR = 4dT$. But the atmospheric circulation, the clouds, the water vapor, the ozone, and other variable characteristics of the atmosphere on the one hand, and differences in the nature and configuration of the earth's surface on the other, introduce secondary modifying influences. It is well known that stations in different longitudes, though of equal latitudes, altitudes, and insolation, not infrequently are found to exhibit opposite weather departures. Indirect effects, in short, may often overpower direct ones in the domain of solar weather control.

11. PREFERRED VALUES OF THE SOLAR CONSTANT OF RADIATION, 1920–1930

Presuming that readers will wish us to choose from the evidence of the four stations the most probable daily, 10-day, and monthly values of the solar constant of radiation, we give the following Tables 45, 46, and 47. As regards monthly mean values there is small question. The astonishingly good accord of the three stations since 1927 and of two stations since 1926 warrants the belief that all of the Montezuma monthly values since 1920 are highly accurate. With moderate changes of scale Mount Harqua Hala monthly values are generally accordant with them. The monthly and 10-day mean values for the years 1920 to 1925 are made up with some consideration of Harqua Hala results.

The 10-day mean values are, of course, not quite so precise as the monthly means, but still in most instances deserve high rating in accuracy.

As for the daily values, we give them in many instances with reluctance and reserve. We have accepted the principle that Montezuma observations generally deserve far greater weight than those of the other stations. We have reduced the values from other stations to agree as closely as possible with the Montezuma scale. When a Montezuma value appearing to be normal in the march of values is available, we have given it greatly preponderating weight whatever other stations might indicate. In the absence of Montezuma values we have been guided by the probable march of values quite as much as by the direct observations of available stations in selecting the most probable values. We warn readers that the daily values are of unequal weight, and that none of them have anything approaching the weight of the monthly means. In order to give some indication of the reliance that may be placed upon them, we have attached to the daily values the grades S, S−, U+, and U.

Prior to December, 1925, we prefer to depend on Montezuma daily values alone as given in Table 31.

TABLE 45.—*Preferred solar constants. Monthly mean values*

Month	Year										
	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
January	1.965	1.957	1.944	1.925	1.938	1.944	1.940	1.941	1.938	1.933	1.941
February	1.956	1.950	1.947	1.925	1.936	1.943	1.936	1.942	1.942	1.933	1.940
March	1.946	1.945	1.940	1.928	1.941	1.939	1.937	1.943	1.945	1.932	1.939
April	1.952	1.947	1.928	1.930	1.942	1.947	1.936	1.944	1.942	1.934	1.941
May	1.954	1.950	1.926	1.930	1.945	1.950	1.940	1.944	1.946	1.936	1.944
June	1.938	1.934	1.916	1.927	1.952	1.945	1.943	1.947	1.948	1.933	1.943
July	1.945	1.951	1.912	1.935	1.946	1.951	1.942	1.945	1.943	1.933	1.943
August	1.930	1.946	1.919	1.941	1.940	1.944	1.943	1.943	1.940	1.932	1.941
September	1.946	1.952	1.918	1.943	1.946	1.951	1.941	1.944	1.939	1.929	1.935
October	1.944	1.956	1.920	1.941	1.950	1.946	1.935	1.944	1.931	1.931	1.935
November	1.948	1.955	1.924	1.939	1.947	1.945	1.932	1.944	1.929	1.938	1.938
December	1.954	1.950	1.926	1.930	1.943	1.945	1.938	1.941	1.928	1.942	1.941

Prior to 1926 these values (plotted in fig. 26B) represent the monthly means computed from Table 47. They represent Calama, Montezuma, and Harqua Hala observations, reduced as well as possible to a common scale. The years 1926 to 1930, inclusive, represent the mean results of Montezuma, Table Mountain, and Mount Brukkaros, as given by the heavy curve of Figure 26*a*. In computing these monthly means the stations were given the following weights, excepting that values for September, 1928, and January, 1929, were omitted at Montezuma, and June, 1927, at Mount Brukkaros.

Weights: Montezuma, 2; Table Mountain, 1; Brukkaros, 1.

TABLE 46.—*Preferred solar constants. Daily values, 1926–1930*

Date	Solar constant and grade
1926	
Jan. 1	1.944 s.
2	1.939 s.
3	1.934 u.+
4	1.931 u.+
5	1.936 u.+
6	1.942 s.−
7	1.944 s.−
8	1.942 s.−
9	1.939 s.−
10	1.940 u.+
	1.939
11	1.941 s.
12	1.939 s.
13	1.944 u.
14	1.940 s.−
15	1.946 s.−
16	1.938 u.+
17	1.941 u.
18	1.944 s.−
19	1.938 u.
20	1.932 u.
	1.940
21	1.931 u.
22	1.930 u.
23	1.932 s.−
24	1.934 s.−
25	1.933 s.−
26	1.932 s.−
27	1.935 u.+
28	1.934 u.+
29	1.935 u.
30	1.936 u.
31	1.937 u.
	1.934
Feb. 1	1.938 u.+
2	1.935 s.−
3	1.931 u.+
4	1.930 u.
5	1.931 u.+
6	1.931 s.
7	1.934 s.
8	1.938 s.
9	1.940 s.
10	1.943 s.
	1.935
11	1.945 s.−
12	1.947 s.−
13	1.950 s.−
14	1.950 s.−
15	1.944 s.−
16	1.928 s.−
17	1.932 s.−
18	1.938 s.
19	1.942 s.
20	1.939 s.
	1.941
21	1.938 u.+
22	1.933 u.+
23	1.928 u.+

Date	Solar constant and grade
1926	
Feb. 24	1.928 u.+
25	1.932 s.−
26	1.924 u.
27	1.927 u.+
28	1.927 u.
	1.930
Mar. 1	1.929 s.−
2	1.932 u.+
3	1.940 s.−
4	1.938 s.−
5	1.940 s.
6	1.941 s.
7	1.941 s.
8	1.940 s.−
9	1.938 u.
10	1.941 s.−
	1.938
11	1.949 u.+
12	1.948 u.+
13	1.944 u.+
14	1.940 u.+
15	1.938 u.
16	1.936 u.
17	1.927 u.+
18	1.932 u.
19	1.935 u.
20	1.937 s.−
	1.939
21	1.929 s.−
22	1.928 u.+
23	1.937 s.
24	1.939 s.
25	1.936 s.−
26	1.936 s.−
27	1.933 s.
28	1.935 s.
29	1.928 s.−
30	1.934 s.−
31	1.936 u.+
	1.934
Apr. 1	1.938 u.+
2	1.922 u.+
3	1.920 u.+
4	1.918 u.+
5	1.927 s.−
6	1.941 s.
7	1.938 s.
8	1.931 s.
9	1.922 s.
10	1.940 s.
	1.930
11	1.944 s.
12	1.941 s.
13	1.941 s.−
14	1.936 s.
15	1.941 u.+
16	1.936 s.−
17	1.929 s.
18	1.929 s.−

Date	Solar constant and grade
1926	
Apr. 19	1.929 s.−
20	1.927 s.−
	1.935
21	1.939 s.
22	1.938 s.−
23	1.936 s.
24	1.937 s.−
25	1.940 s.
26	1.935 s.
27	1.936 s.−
28	1.942 u.+
29	1.947 u.+
30	1.954 s.−
	1.940
May 1	1.943 s.−
2	1.948 s.−
3	1.938 s.−
4	1.937 s.−
5	1.918 s.−
6	1.929 s.−
7	1.941 s.−
8	1.945 s.−
9	1.937 s.−
10	1.942 s.−
	1.938
11	1.938 u.
12	1.926 u.+
13	1.925 u.+
14	1.936 s.−
15	1.942 s.
16	1.943 s.−
17	1.944 u.
18	1.941 s.−
19	1.940 s.
20	1.941 s.−
	1.938
21	1.942 s.
22	1.950 s.−
23	1.946 u.+
24	1.936 s.−
25	1.940 s.−
26	1.938 s.−
27	1.940 s.−
28	1.946 s.−
29	(1.945) u.+
30	(1.945) u.+
31	(1.945) u.+
	1.943
June 1	1.945 u.
2	1.941 u.
3	1.938 u.
4	1.931 u.
5	1.934 u.
6	1.937 u.+
7	1.938 u.+
8	1.939 u.+
9	1.941 u.+
10	1.942 u.+
	1.939

Date	Solar constant and grade
1926	
June 11	1.940 s.−
12	1.942 u.+
13	1.949 s.−
14	1.951 s.−
15	1.951 s.−
16	1.943 s.−
17	1.940 s.−
18	1.942 s.−
19	1.946 s.
20	1.943 s.
	1.945
21	1.945 s.
22	1.941 u.+
23	1.938 u.
24	1.940 s.−
25	1.941 s.−
26	1.946 u.+
27	1.941 s.−
28	1.940 s.−
29	1.938 u.+
30	1.936 s.−
	1.941
July 1	1.937 s.−
2	1.938 s.
3	1.942 s.−
4	1.944 u.+
5	1.940 s.−
6	1.940 s.
7	1.939 s.−
8	1.943 s.−
9	1.942 s.−
10	1.943 s.
	1.941
11	1.944 s.
12	1.954 s.
13	1.946 s.
14	1.950 u.+
15	1.948 s.−
16	1.947 s.
17	1.944 s.
18	1.942 u.+
19	1.932 s.−
20	1.931 s.−
	1.944
21	1.944 u.+
22	1.938 s.
23	1.942 s.−
24	1.930 s.
25	1.939 s.−
26	1.942 s.−
27	1.943 s.−
28	1.942 s.−
29	1.937 s.
30	1.945 s.
31	1.947 s.
	1.941
Aug. 1	1.943 s.−
2	1.941 s.−
3	1.946 s.−

Date	Solar constant and grade
1926	
Aug. 4	1.943 u.+
5	1.938 s.−
6	1.942 u.+
7	1.946 u.
8	1.944 u.
9	1.942 u.
10	1.948 u.+
	1.943
11	1.949 s.
12	1.945 s.−
13	1.940 s.−
14	1.938 u.+
15	1.935 s.−
16	1.940 s.
17	1.947 s.−
18	1.941 s.−
19	1.935 u.
20	1.941 s.−
	1.941
21	1.946 u.
22	1.940 s.−
23	1.938 u.
24	1.936 u.+
25	1.938 s.−
26	1.946 s.
27	1.847 s.−
28	1.940 s.
29	1.947 s.
30	1.944 s.−
31	1.941 s.−
	1.942
Sept. 1	1.943 s.−
2	1.945 s.
3	1.940 s.
4	1.938 s.
5	1.943 s.−
6	1.942 s.−
7	1.943 u.+
8	1.939 s.
9	1.939 s.
10	1.936 s.−
	1.941
11	1.930 s.
12	1.930 s.−
13	1.932 s.−
14	1.935 s.−
15	1.938 s.−
16	1.941 s.−
17	1.944 s.−
18	1.947 s.
19	1.944 s.−
20	1.943 s.−
	1.938
21	1.943 s.
22	1.939 s.
23	1.943 s.
24	1.946 s.
25	1.943 s.−
26	1.944 s.−

TABLE 46.—*Preferred solar constants. Daily values, 1926–1930*—Continued

Date	Solar constant and grade
1926	
Sept. 27	1.947 s.–
28	1.946 s.–
29	1.942 s.–
30	1.937 s.
	1.943
Oct. 1	1.935 s.–
2	1.942 s.
3	1.942 s.
4	1.935 s.–
5	1.930 s.
6	1.932 u.+
7	1.930 s.
8	1.936 u.+
9	1.942 s.
10	1.940 s.
	1.936
11	1.938 s.
12	1.944 s.
13	1.944 s.
14	1.938 s.–
15	1.934 s.
16	1.932 s.–
17	1.929 s.
18	1.936 s.
19	1.940 s.–
20	1.935 s.–
	1.937
21	1.936 s.–
22	1.936 s.
23	1.934 s.
24	1.930 s.–
25	1.927 s.–
26	1.927 u.+
27	1.928 u.+
28	1.932 s.
29	1.934 s.
30	1.930 s.
31	1.925 s.
	1.931
Nov. 1	1.934 s.
2	1.930 s.
3	1.935 s.–
4	1.933 s.–
5	1.932 u.+
6	1.937 s.
7	1.934 s.–
8	1.930 s.–
9	1.929 s.–
10	1.930 s.–
	1.932
11	1.930 s.
12	1.932 u.+
13	1.935 s.–
14	1.934 s.–
15	1.928 u.
16	1.925 u.
17	1.926 u.
18	1.929 u.
19	1.930 u.
20	1.932 s.–
	1.930

Date	Solar constant and grade
1926	
Nov. 21	1.933 u.+
22	1.933 u.+
23	1.933 u.+
24	1.933 s.–
25	1.933 u.+
26	1.933 u.
27	1.932 u.
28	1.931 u.+
29	1.931 u.
30	1.932 s.
	1.932
Dec. 1	1.933 u.
2	1.933 u.
3	1.933 u.
4	1.934 u.
5	1.935 u.
6	1.935 u.
7	1.936 u.
8	1.937 u.
9	1.938 s.–
10	1.939 s–.
	1.935
11	1.938 s.–
12	1.940 s.
13	1.937 s.–
14	1.936 s.
15	1.933 s.–
16	1.934 s.–
17	1.931 u.
18	1.928 u.+
19	1.932 u.+
20	1.935 u.+
	1.934
21	1.937 u.
22	1.937 s.–
23	1.936 u.
24	1.935 s.–
25	1.933 s.
26	1.929 s.–
27	1.932 s.–
28	1.935 u+.
29	1.938 s.–
30	1.938 s.–
31	1.934 s.
	1.935
1927	
Jan. 1	1.933 s.
2	1.937 s.–
3	1.940 s.–
4	1.944 s.–
5	1.933 s.
6	1.930 s.–
7	1.944 s.–
8	1.947 s.–
9	1.946 u.+
10	1.947 u.+
	1.940
11	1.945 u.+
12	1.943 s.–
13	1.940 s.–

Date	Solar constant and grade
1927	
Jan. 14	1.940 s.–
15	1.940 u.
16	1.940 u.
17	1.936 u.+
18	1.934 u.+
19	1.935 u.
20	1.936 u.
	1.939
21	1.935 u.
22	1.935 u.+
23	1.935 s.–
24	1.934 s.–
25	1.936 u.+
26	1.938 u.
27	1.938 u.
28	1.939 u.
29	1.939 u.
30	1.940 u.
31	1.941 s.–
	1.937
Feb. 1	1.940 s.–
2	1.940 s.–
3	1.940 u.
4	1.941 s.–
5	1.939 u.
6	1.940 u.
7	1.940 u.+
8	1.935 u.+
9	1.937 s.–
10	1.943 s.–
	1.939
11	1.941 s.–
12	1.940 s.–
13	1.944 s.–
14	1.945 s.–
15	1.945 s.–
16	1.946 s.
17	1.945 s.
18	1.944 s.–
19	1.945 u.
20	1.945 u.+
	1.944
21	1.944 u.+
22	1.944 u.
23	1.942 u.
24	1.942 u.
25	1.943 u.+
26	1.942 u.+
27	1.942 u.+
28	1.942 s.–
	1.942
Mar. 1	1.941 u.+
2	1.941 s.–
3	1.939 u.
4	1.937 u.+
5	1.936 u.+
6	1.934 u.
7	1.933 s.–

Date	Solar constant and grade
1927	
Mar. 8	1.937 s.–
9	1.932 u.+
10	1.930 u.+
	1.936
11	1.933 s.–
12	1.938 s.
13	1.942 s.
14	1.942 s.–
15	1.942 s.
16	1.944 u.+
17	1.948 s.–
18	1.946 s.–
19	1.945 s.
20	1.949 s.–
	1.943
21	1.951 s.
22	1.945 s.
23	1.950 s.–
24	1.949 s.–
25	1.948 s.–
26	1.951 s.
27	1.946 s.–
28	1.942 s.–
29	1.930 u.
30	1.934 u.
31	1.932 u.
	1.943
Apr. 1	1.940 u.
2	1.945 s.
3	1.944 s.
4	1.950 u.+
5	1.950 u.+
6	1.947 s.–
7	1.943 s.–
8	1.941 s.–
9	1.940 s.
10	1.942 s.
	1.944
11	1.944 s.–
12	1.950 s.–
13	1.950 s.–
14	1.940 s.
15	1.945 s.
16	1.952 s.
17	1.944 s.
18	1.950 s.–
19	1.947 s.–
20	1.944 s.–
	1.947
21	1.952 s.
22	1.948 s.–
23	1.940 s.–
24	1.933 u.+
25	1.941 s.
26	1.945 s.–
27	1.950 s.
28	1.952 s.
29	1.946 s.
30	1.943 s.
	1.945

Date	Solar constant and grade
1927	
May 1	1.942 s.–
2	1.943 s.
3	1.944 s.
4	1.950 s.
5	1.951 s.–
6	1.949 s.–
7	1.947 s.
8	1.945 s.–
9	1.949 s.
10	1.944 s.
	1.946
11	1.943 s.
12	1.940 s.
13	1.945 s.
14	1.945 s.–
15	1.945 s.–
16	1.940 s.–
17	1.937 s.–
18	1 938 s.
19	1.943 s.–
20	1.947 s.–
	1.942
21	1.946 s.–
22	1.941 s.
23	1.944 s.
24	1.942 s.–
25	1.940 u.+
26	1.943 s.–
27	1.947 s.–
28	1.941 s.
29	1.950 s.
30	1.946 s.
31	1.948 s.–
	1.945
June 1	1.950 s.–
2	1.952 s.–
3	1.952 s.
4	1.950 s.
5	1.951 s.
6	1.953 s.
7	1.951 s.
8	1.951 s.
9	1.949 s.
10	1.946 s.
	1.950
11	1.945 s.–
12	1.943 s.–
13	1.941 s.–
14	1.940 s.–
15	1.938 s.–
16	1.944 s.
17	1.948 s.
18	1.947 s,–
19	1.946 u.+
20	1.945 s.–
	1.944
21	1.942 s.–
22	1.941 s.–
23	1.942 s.
24	1.946 s.

TABLE 46.—*Preferred solar constants. Daily values, 1926–1930*—Continued

Date	Solar constant and grade	Date	Solar constant and grade	Date	Solar constant and grade	Date	Solar constant and grade	Date	Solar constant and grade
1927		1927		1927		1927		1928	
June 25	1.951 s.−	Aug. 19	1.936 s.−	Oct. 11	1.945 s.	Dec. 5	1.936 s.−	Jan. 28	1.939 s.
26	1.946 s.−	20	1.938 s.−	12	1.948 s.	6	1.940 s.−	29	1.940 s.−
27	1.944 s.			13	1.945 s.−	7	1.946 s.−	30	1.946 s.−
28	1.946 s.		1.940	14	1.943 s.−	8	1.946 s.	31	1.946 s.−
29	1.950 s.			15	1.941 s.	9	1.948 s.		
30	1.947 u.+	21	1.934 s.−	16	1.943 s.	10	1.945 s.		1.937
		22	1.936 s.−	17	1.944 s.−				
	1.945	23	1.934 s.−	18	1.941 s.−		1.944	Feb. 1	1.942 s.
		24	1.936 s.	19	1.940 s.−			2	1.945 s.−
July 1	1.949 s.	25	1.936 s.	20	1.943 s.	11	1.942 s.−	3	1.941 s.−
2	1.953 s.	26	1.939 s.			12	1.937 s.	4	1.942 u.+
3	1.950 s.−	27	1.941 s.		1.943	13	1.942 u.+	5	1.940 s.
4	1.948 s.−	28	1.948 s.			14	1.944 s.	6	1.948 u.+
5	1.952 s.	29	1.950 s.	21	1.946 s.−	15	1.933 u.+	7	1.953 s.−
6	1.947 s.	30	1.954 s.	22	1.945 s.	16	1.932 u.+	8	1.949 s.−
7	1.944 s.	31	1.951 s	23	1.941 s.−	17	1.933 u.+	9	1.946 s.−
8	1.945 s.−			24	1.938 s.−	18	1.938 u.+	10	1.935 s.−
9	1.946 s.−		1.942	25	1.945 s.−	19	1.939 u.+		
10	1.945 s.			26	1.941 s.−	20	1.936 u.		1.944
		Sept. 1	1.942 s.−	27	1.936 s.−				
	1.948	2	1.941 s.−	28	1.933 s.−		1.938	11	1.938 s.
		3	1.943 s.−	29	1.942 s.			12	1.942 s.
11	1.943 s.	4	1.947 s.−	30	1.942 s.−	21	1.934 u.	13	1.940 s.−
12	1.940 s.−	5	1.948 s.−	31	1.943 s.	22	1.932 s.−	14	1.942 s.
13	1.941 s.	6	1.944 s.−			23	1.936 u.+	15	1.940 s.
14	1.944 s.−	7	1.941 s.−		1.941	24	1.939 u.+	16	1.941 s.
15	1.945 s.−	8	1.938 u.+			25	1.942 s.−	17	1.938 s.−
16	1.947 s.−	9	1.935 s.−	Nov. 1	1.944 s.	26	1.939 s.	18	1.942 s.
17	1.948 s.	10	1.936 s.−	2	1.940 s.	27	1.938 s.	19	1.938 s.
18	1.946 s.			3	1.945 s.	28	1.944 s.	20	1.937 s.
19	1.944 s.		1.941	4	1.938 s.	29	1.938 s.−		
20	1.949 s.−			5	1.935 u.+	30	1.940 s.		1.940
		11	1.939 s.−	6	1.940 u.+	31	1.940 u.		
	1.945	12	1.939 s.−	7	1.948 s.			21	1.941 s.−
		13	1.942 s.−	8	1.947 s.−		1.938	22	1.942 u.+
21	1.949 s.−	14	1.945 s.−	9	1.949 s.			23	1.943 u.+
22	1.944 s.	15	1.946 s.−	10	1.946 s.	1928		24	1.944 u.+
23	1.945 s.	16	1.938 s.			Jan. 1	1.939 u.	25	1.940 u.+
24	1.948 s.	17	1.939 s.		1.943	2	1.938 u.	26	1.939 s.−
25	1.951 s.	18	1.937 s.			3	1.935 s.−	27	1.939 s.−
26	1.950 s.−	19	1.942 s.	11	1.940 s.	4	1.938 s.−	28	1.940 s.−
27	1.947 s.−	20	1.943 s.	12	1.944 s.	5	1.942 s.−	29	1.938 s.−
28	1.945 s.−			13	1.948 s.−	6	1.939 s.		
29	1.942 s.−		1.941	14	1.947 s.−	7	1.940 s.−		1.941
30	1.945 s.			15	1.946 s.−	8	1.943 s.−		
31	1.945 s.	21	1.948 s.−	16	1.944 s.	9	1.935 s.	Mar. 1	1.942 u.+
		22	1.949 s.−	17	1.944 s.	10	1.932 s.−	2	1.944 s.−
	1.946	23	1.949 s.	18	1.942 s.−			3	1.947 s.
		24	1.946 s.	19	1.937 s.−		1.937	4	1.950 s.−
Aug. 1	1.943 s.−	25	1.946 s.−	20	1.940 s.−			5	1.940 s.−
2	1.945 s.	26	1.947 s.−			11	1.930 s.	6	1.943 s.−
3	1.942 s.	27	1.948 s.−		1.943	12	1.933 u.+	7	1.947 s.
4	1.941 s.	28	1.947 s.−			13	1.934 s.−	8	1.949 s.
5	1.942 s.−	29	1.948 s.−	21	1.942 u.+	14	1.936 s.−	9	1.960 s.
6	1.942 s.−	30	1.950 s.	22	1.945 s.−	15	1.938 u.	10	1.946 s.−
7	1.947 s.			23	1.942 s.	16	1.932 s.		
8	1.944 s.		1.948	24	1.947 s.	17	1.929 u.		1.947
9	1.943 s.−			25	1.939 s.−	18	1.926 s.−		
10	1.941 s.−	Oct. 1	1.949 s.−	26	1.938 u.+	19	1.930 u.+	11	1.941 s.−
		2	1.946 s.−	27	1.939 s.−	20	1.932 u.+	12	1.957 s.
	1.943	3	1.948 s.	28	1.942 s.−			13	1.953 s.−
		4	1.945 s.−	29	1.944 s.−		1.932	14	1.950 s.−
11	1.939 u.+	5	1.946 s.	30	1.949 s.−			15	1.942 s.−
12	1.938 u.	6	1.947 s.			21	1.936 s.−	16	1.939 s.
13	1.937 u.+	7	1.946 s.		1.943	22	1.935 s.−	17	1.933 u.+
14	1.938 s.−	8	1.943 s.			23	1.932 u.	18	1.940 s.
15	1.943 s.−	9	1.939 s.−	Dec. 1	1,950 s.−	24	1.933 s.−	19	1.956 s.−
16	1.943 s.−	10	1.943 s.−	2	1.947 s.−	25	1.932 u.	20	1.951 s.−
17	1.944 s.−			3	1.942 s.	26	1.932 s.−		
18	1.941 u.+		1.945	4	1.931 s.	27	1.931 s.−		1.946

TABLE 46.—*Preferred solar constants. Daily values, 1926–1930*—Continued

Date	Solar constant and grade
1928	
Mar. 21	1.946 s.−
22	1.940 s.−
23	1.934 s.
24	1.940 s.−
25	1.947 s.
26	1.943 s.
27	1.955 s.
28	1.950 u.+
29	1.946 s.−
30	1.937 s.−
31	1.940 s.
	1.945
Apr. 1	1.933 s.
2	1.948 s.
3	1.943 s.−
4	1.931 u.+
5	1.946 u.+
6	1.950 s.−
7	1.945 s.
8	1.943 s.
9	1.941 s.−
10	1.938 s.−
	1.943
11	1.938 s.
12	1.937 s.
13	1.939 s.−
14	1.936 s.−
15	1.940 s.
16	1.940 s.−
17	1.940 s.−
18	1.939 u.+
19	1.938 s.−
20	1.945 s.−
	1.939
21	1.950 u.+
22	1.948 u.+
23	1.944 u.+
24	1.945 s.
25	1.942 s.−
26	1.940 s.
27	1.938 s.−
28	1.938 s.
29	1.938 s.
30	1.939 s.−
	1.942
May 1	1.940 s.−
2	1.943 s.−
3	1.944 u.+
4	1.934 s.−
5	1.938 s.−
6	1.947 s.−
7	1.946 s.−
8	1.947 s.−
9	1.940 s.−
10	1.945 s.−
	1.942
11	1.949 s.−
12	1.946 s.−
13	1.947 s.
14	1.947 s.

Date	Solar constant and grade
1928	
May 15	1.942 u.+
16	1.945 u.
17	1.944 u.+
18	1.954 s.−
19	1.955 s.−
20	1.957 u.+
	1.949
21	1.958 u.+
22	1.952 s.−
23	1.944 u.+
24	1.942 u.+
25	1.938 s.−
26	1.941 s.−
27	1.941 s.−
28	1.942 s.−
29	1.944 s.
30	1.946 s.−
31	1.948 u.+
	1.946
June 1	1.950 s.
2	1.945 s.
3	1.944 s.−
4	1.944 s.−
5	1.946 s.−
6	1.948 s.
7	1.953 s.
8	1.948 s.−
9	1.940 s.−
10	1.945 s.−
	1.946
11	1.947 s.−
12	1.942 u.+
13	1.945 s.−
14	1.952 u.+
15	1.954 u.
16	1.955 s.−
17	1.954 s.−
18	1.952 u.+
19	1.954 s.−
20	1.955 u.+
	1.951
21	1.952 s.
22	1.956 u.
23	1.948 u.+
24	1.941 u.+
25	1.946 s.−
26	1.946 s.−
27	1.944 s.−
28	1.937 s.−
29	1.940 s.
30	1.944 s.−
	1.945
July 1	1.947 s.−
2	1.946 s.
3	1.942 s.−
4	1.939 s.−
5	1.937 s.
6	1.942 s.−
7	1.950 s.
8	1.945 s.−

Date	Solar constant and grade
1928	
July 9	1.945 s.−
10	1.941 s.
	1.943
11	1.938 s.−
12	1.937 u.
13	1.937 u.
14	1.936 s.−
15	1.938 s.−
16	1.936 s.−
17	1.938 s.−
18	1.942 s.
19	1.946 s.
20	1.939 s.−
	1.939
21	1.937 s.−
22	1.940 s.−
23	1.938 u.+
24	1.926 s.
25	1.940 s.
26	1.943 s.
27	1.944 u.+
28	1.940 s.−
29	1.942 u.+
30	1.942 s.
31	1.943 u.
	1.940
Aug. 1	1.944 u.
2	1.944 u.+
3	1.945 u.
4	1.945 s.
5	1.950 u.+
6	1.943 s.−
7	1.939 s.
8	1.935 s.−
9	1.933 s.−
10	1.930 s.−
	1.941
11	1.928 u.+
12	1.930 u.+
13	1.932 s.−
14	1.935 s.−
15	1.938 u.+
16	1.939 s.
17	1.937 u.+
18	1.937 s.
19	1.941 s.
20	1.938 s.−
	1.934
21	1.936 u.+
22	1.929 s.
23	1.928 s.
24	1.931 s.−
25	1.935 s.−
26	1.936 u.+
27	1.943 u.+
28	1.948 u.
29	1.947 u.
30	1.946 u.+
31	1.942 u.+
	1.938

Date	Solar constant and grade
1928	
Sept. 1	1.941 s.−
2	1.934 s.−
3	1.937 u.
4	1.939 u.
5	1.944 u.
6	1.954 u.
7	1.941 u.
8	1.935 u.
9	1.947 u.
10	1.940 u.
	1.941
11	1.935 s.−
12	1.937 s.−
13	1.938 u.+
14	1.932 u.+
15	1.922 u.
16	1.933 s.−
17	1.936 s.−
18	1.934 u.+
19	1.941 s.−
20	1.939 s.
	1.935
21	1.941 s.
22	1.932 u.
23	1.923 s.−
24	1.928 u.+
25	1.930 s.−
26	1.924 u.
27	1.918 s.
28	1.905 s.−
29	1.910 s.−
30	1.922 s.−
	1.923
Oct. 1	1.924 s.−
2	1.928 s.
3	1.934 s.−
4	1.935 s.
5	1.932 s.
6	1.930 s.
7	1.929 s.
8	1.927 s.−
9	1.922 s.−
10	1.926 s.
	1.929
11	1.928 s.
12	1.931 s.−
13	1.935 s.−
14	1.936 s.−
15	1.940 u.
16	1.936 u.
17	1.932 u.
18	1.928 s.−
19	1.932 u.+
20	1.926 s.−
	1.932
21	1.924 u.+
22	1.924 u.+
23	1.926 u.
24	1.932 u.
25	1.934 s.−

Date	Solar constant and grade
1928	
Oct. 26	1.929 s.
27	1.918 s.−
28	1.924 s.−
29	1.929 s.−
30	1.928 s.
31	1.926 s.−
	1.927
Nov. 1	1.923 s.−
2	1.930 u.
3	1.918 s.−
4	1.922 s.−
5	1.924 u.+
6	1.925 s.−
7	1.927 s.−
8	1.929 s.−
9	1.927 s.
10	1.926 s.−
	1.925
11	1.918 u.
12	1.921 u.
13	1.924 s.−
14	1.930 s.−
15	1.929 s.−
16	1.928 s.
17	1.928 s.−
18	1.934 u.+
19	1.938 s.
20	1.936 u.+
	1.929
21	1.932 u.
22	1.927 s.
23	1.928 s.−
24	1.932 s.−
25	1.923 s.−
26	1.926 s.−
27	1.932 s.−
28	1.934 s.−
29	1.939 s.
30	1.925 s.−
	1.930
Dec. 1	1.931 s.
2	1.936 u.
3	1.935 s.−
4	1.926 s.−
5	1.926 u.
6	1.923 s.
7	1.925 s.−
8	1.929 s.−
9	1.926 u.+
10	1.930 u.+
	1.929
11	1.938 u.+
12	1.927 u.+
13	1.925 s.−
14	1.928 s.−
15	1.923 s.
16	1.919 s.
17	1.923 s.−
18	1.929 s.

TABLE 46.—*Preferred solar constants. Daily values, 1926–1930*—Continued

Date	Solar constant and grade
1928	
Dec. 19	1.924 s.–
20	1.922 u.+
	1.926
21	1.925 u.+
22	1.932 s.
23	1.930 u.+
24	1.928 u.+
25	1.930 s.–
26	1.932 u.
27	1.934 u.
28	1.936 u.
29	1.938 u.
30	1.934 u.
31	1.928 u.+
	1.932
1929	
Jan. 1	1.926 u.
2	1.934 u.
3	1.935 u.+
4	1.934 u.
5	1.932 u.
6	1.930 u.
7	1.927 s.–
8	1.925 u.+
9	1.928 u.+
10	1.924 s.–
	1.929
11	1.922 s.–
12	1.918 s.–
13	1.928 u.
14	1.938 u.
15	1.947 s.–
16	1.935 s.–
17	1.947 s.–
18	1.934 s.–
19	1.928 u.
20	1.935 s.–
	1.933
21	1.948 s.–
22	1.934 s.–
23	1 928 s.–
24	1.924 s.–
25	1.931 s.–
26	1.933 s.–
27	1.934 s.–
28	1.932 u.
29	1.930 u.
30	1.924 u.+
31	1.938 s.–
	1.932
Feb. 1	1.935 u.
2	1.930 u.+
3	1.926 u.+
4	1.928 u.
5	1.931 u.+
6	1.933 u.+
7	1.936 s.
8	1.941 s.
9	1.939 s.–
10	1.928 s.–
	1.933

Date	Solar constant and grade
1929	
Feb. 11	1.928 s.–
12	1.930 s.–
13	1.915 s.–
14	1.922 u.+
15	1.924 s.–
16	1.925 s.–
17	1.930 u.+
18	1.936 u+.
19	1.934 s.–
20	1.924 s.–
	1.927
21	1.932 s.–
22	1.920 s.–
23	1.926 s.
24	1.930 s.–
25	1.936 s.–
26	1.934 s.–
27	1.931 s.–
28	1.930 s.–
	1.930
Mar. 1	1.932 s.–
2	1.931 s.–
3	1.927 u.+
4	1.922 u.+
5	1.929 s.–
6	1.934 s.
7	1.930 s.
8	1.928 u.+
9	1.930 s.–
10	1.927 u.+
	1.929
11	1.924 u.
12	1.928 s.
13	1.925 s.–
14	1.914 s.–
15	1.933 s.–
16	1.935 s.
17	1.930 s.
18	1.940 s.
19	1.933 s.
20	1.932 s.
	1.930
21	1.930 s.
22	1.933 s.–
23	1.937 s.–
24	1.939 s.–
25	1.933 s.–
26	1.927 u.+
27	1.928 s.
28	1.928 s.–
29	1.926 u.
30	1.924 u.
31	1.933 s.–
	1.931
Apr. 1	1.935 s.–
2	1.936 s.–
3	1.937 s.–
4	1.926 u.+
5	1.932 s.–

Date	Solar constant and grade
1929	
Apr. 6	1.931 s.–
7	1.931 s.
8	1.929 s.–
9	1.925 s.–
10	1.934 u.
	1.932
11	1.938 s.–
12	1.942 s.
13	1.944 s.–
14	1.940 s.
15	1.942 s.–
16	1.944 s.–
17	1.936 s.–
18	1.935 s.–
19	1.936 s.
20	1.938 s.–
	1.940
21	1.938 s.–
22	1.939 s.
23	1.940 s.–
24	1.936 s.–
25	1.938 s.–
26	1.940 s.
27	1.938 s.–
28	1.930 s.
29	1.936 s.–
30	1.940 s.
	1.937
May 1	1.945 s.–
2	1.937 s.–
3	1.940 s.–
4	1.939 s.
5	1.936 s.
6	1.932 s.
7	1.938 s.–
8	1.942 u.
9	1.936 u.
10	1.933 s.–
	1.938
11	1.930 u.+
12	1.936 u.+
13	1.930 u.+
14	1.929 u.+
15	1.936 s.–
16	1.937 u.+
17	1.938 s.–
18	1.934 s.–
19	1.936 s.–
20	1.934 s.–
	1.934
21	1.934 u.
22	1.933 s.–
23	1.932 s.–
24	1.935 s.–
25	1.938 s.–
26	1.935 s.
27	1.934 s.
28	1.936 s.–
29	1.934 s.–

Date	Solar constant and grade
1929	
May 30	1.936 s.–
31	1.936 s.–
	1.935
June 1	1.935 s.–
2	1.940 s.–
3	1.940 s.–
4	1.938 u.
5	1.931 s.
6	1.936 u.+
7	1.942 u.+
8	1.934 u.
9	1.930 u.
10	1.926 u.
	1.935
11	1.933 s.
12	1.924 s.–
13	1.928 s.–
14	1.936 s.–
15	1.931 s.–
16	1.928 u.+
17	1.932 u.
18	1.935 u.
19	1.937 u.+
20	1.936 u.+
	1.932
21	1.932 u.
22	1.930 s.
23	1.932 s.–
24	1.930 s.
25	1.936 s.–
26	1.934 s.–
27	1.933 u.
28	1.933 u.
29	1.932 s.–
30	1.932 s.–
	1.932
July 1	1.930 s.–
2	1.938 s.–
3	1.940 s.–
4	1.934 s.–
5	1.926 s.–
6	1.926 s.–
7	1.930 s.–
8	1.932 s.–
9	1.935 s.
10	1.939 s.
	1.933
11	1.931 s.–
12	1.930 s.
13	1.934 s.
14	1.937 s.–
15	1.931 s.
16	1.936 s.–
17	1.930 u.
18	1.924 u.+
19	1.937 s.–
20	1.930 s.–
	1.932

Date	Solar constant and grade
1929	
July 21	1.931 s.
22	1.930 s.–
23	1.936 s.–
24	1.946 s.–
25	1.942 u.
26	1.938 s.
27	1.930 s.
28	1.929 s.–
29	1.927 u.+
30	1.929 s.
31	1.934 s.–
	1.934
Aug. 1	1.932 u.+
2	1.929 s.–
3	1.929 s.–
4	1.933 s.–
5	1.929 s.–
6	1.926 s.
7	1.929 s.
8	1.932 s.
9	1.937 s.–
10	1.937 s.–
	1.931
11	1.933 s.–
12	1.934 s.–
13	1.933 s.–
14	1.931 s.–
15	1.930 s.–
16	1.929 s.–
17	1.929 s.
18	1.931 s.–
19	1.934 u.+
20	1.938 s.–
	1.932
21	1.937 s.–
22	1.934 u.
23	1.931 u.
24	1.930 s.–
25	1.931 s.
26	1.928 s.
27	1.926 u.
28	1.928 u.
29	1.931 s.–
30	1.925 s.–
31	1.929 s.–
	1.930
Sept. 1	1.927 s.
2	1.932 u.
3	1.935 u.+
4	1.930 s.–
5	1.930 s.
6	1.926 s.–
7	1.922 s.–
8	1.924 s.–
9	1.928 s.–
10	1.924 s.–
	1.928
11	1.924 s.
12	1.923 s.
13	1.929 s.

TABLE 46.—*Preferred solar constants. Daily values, 1926–1930*—Continued

Date	Solar constant and grade
1929	
Sept. 14	1.928 s.
15	1.925 s.
16	1.927 s.—
17	1.929 u.
18	1.932 s.—
19	1.930 s.
20	1.934 s.—
	1.928
21	1.923 s.
22	1.926 s.—
23	1.934 s.
24	1.935 s.
25	1.935 s.
26	1.936 s.
27	1.934 u.+
28	1.930 s.—
29	1.931 s.
30	1.933 s.
	1.932
Oct. 1	1.934 u.+
2	1.937 s.—
3	1.933 s.
4	1.929 s.
5	1.924 u.+
6	1.928 u.+
7	1.929 u.+
8	1.930 u.+
9	1.933 s.
10	1.932 s.
	1.931
11	1.931 s.
12	1.932 s.—
13	1.934 s.—
14	1.936 s.—
15	1.938 s.—
16	1.940 s.
17	1.936 s.
18	1.933 s.
19	1.929 s.—
20	1.926 u.+
	1.933
21	1.928 u.+
22	1.930 u.+
23	1.931 u.+
24	1.931 u.+
25	1.931 u.+
26	1.931 u.+
27	1.923 s.—
28	1.928 s.—
29	1.931 s.—
30	1.934 s.—
31	1.935 s.—
	1.930
Nov. 1	1.932 s.—
2	1.929 s.
3	1.935 s.
4	1.928 s.
5	1.928 s.—
6	1.935 s.—
7	1.930 s.—
1929	
Nov. 8	1.933 s.
9	1.933 s.
10	1.941 s.
	1.932
11	1.934 s.
12	1.931 s.
13	1.935 s.
14	1.940 s.
15	1.938 s.
16	1.938 s.
17	1.933 s.—
18	1.931 s.—
19	1.940 s.
20	1.931 s.
	1.935
21	1.937 s.
22	1.939 s.—
23	1.940 s.
24	1.938 s.
25	1.941 s.
26	1.937 s.
27	1.943 s.—
28	1.941 s.
29	1.942 s.
30	1.938 s.
	1.940
Dec. 1	1.941 s.—
2	1.942 s.
3	1.940 s.
4	1.942 s.—
5	1.944 s.—
6	1.942 s.
7	1.942 s.
8	1.940 s.—
9	1.939 s.—
10	1.938 s.
	1.941
11	1.939 s.
12	1.946 s.—
13	1.938 s.
14	1.937 s.—
15	1.934 u.+
16	1.931 s.—
17	1.936 u.+
18	1.940 u.+
19	1.944 s.—
20	1.947 s.
	1.939
21	1.947 u.+
22	1.946 u.+
23	1.936 s.
24	1.934 u.+
25	1.935 u.+
26	1.935 s.
27	1.936 s.
28	1.942 s.
29	1.939 u.+
30	1.931 u.+
31	1.943 s.
	1.939
1930	
Jan. 1	1.946 s.
2	1.940 s.
3	1.937 s.
4	1.935 s.
5	1.933 s.—
6	1.931 u.+
7	1.929 u.+
8	1.930 u.+
9	1.932 u.+
10	1.934 s.—
	1.935
11	1.939 s.—
12	1.936 u.+
13	1.931 s.—
14	1.938 s.—
15	1.938 s.—
16	1.940 s.—
17	1.942 s.—
18	1.939 s.
19	1.936 s.—
20	1.940 u.+
	1.938
21	1.943 u.+
22	1.947 u.+
23	1.940 u.+
24	1.934 u.+
25	1.927 s.—
26	1.930 s.—
27	1.932 s.—
28	1.939 u.+
29	1.936 u.+
30	1.933 u.+
31	1.930 s.
	1.936
Feb. 1	1.931 s.—
2	1.931 s.—
3	1.931 s.
4	1.934 s.—
5	1.940 s.
6	1.935 s.
7	1.932 s.—
8	1.933 s.
9	1.936 s.—
10	1.938 s.—
	1.934
11	1.943 s.—
12	1.935 s.
13	1.931 u.+
14	1.937 s.
15	1.939 s.—
16	1.943 u.+
17	1.945 u.+
18	1.946 u.+
19	1.943 u.+
20	1.942 u.+
	1.940
21	1.944 u.+
22	1.945 s.—
23	1.939 s.—
24	1.941 s.—
25	1.944 s.—
1930	
Feb. 26	1.946 s.—
27	1.945 s.—
28	1.943 s.—
	1.943
Mar. 1	1.941 s.—
2	1.945 s.—
3	1.940 s.—
4	1.940 s.—
5	1.939 s.—
6	1.937 s.—
7	1.938 u.+
8	1.939 u.+
9	1.941 s.—
10	1.938 s.—
	1.940
11	1.933 s.—
12	1.935 s.—
13	1.940 s.
14	1.935 s.—
15	1.937 u.+
16	1.940 u.+
17	1.944 s.—
18	1.938 s.—
19	1.938 s.—
20	1.931 s.
	1.937
21	1.932 s.—
22	1.933 s.
23	1.936 s.
24	1.949 s.
25	1.952 u.+
26	1.946 s.—
27	1.937 u.+
28	1.939 s.
29	1.934 s.
30	1.934 s.
31	1.940 s.—
	1.939
Apr. 1	1.940 u.+
2	1.939 s.—
3	1.945 s.—
4	1.936 s.—
5	1.942 s.—
6	1.940 s.—
7	1.939 s.—
8	1.943 s.—
9	1.943 s.
10	1.945 s.
	1.941
11	1.941 s.—
12	1.939 s.—
13	1.934 u.+
14	1.940 s.
15	1.942 s.—
16	1.940 s.—
17	1.933 s.—
18	1.935 s.—
19	1.934 s.—
20	1.942 s.
	1.938
1930	
Apr. 21	1.936 s.—
22	1.933 s.—
23	1.940 s.
24	1.947 s.—
25	1.940 u.+
26	1.936 u.+
27	1.938 s.—
28	1.945 s.—
29	1.937 s.—
30	1.935 u.
	1.939
May 1	1.943 u.
2	1.946 u.+
3	1.952 u.+
4	1.950 u.+
5	1.939 u.+
6	1.947 s.
7	1.941 s.—
8	1.936 u.+
9	1.934 u.+
10	1.933 u.+
	1.942
11	1.932 u.+
12	1.932 u.+
13	1.941 u.+
14	1.942 u.+
15	1.942 u.+
16	1.942 u.+
17	1.944 s.—
18	1.949 s.—
19	1.948 s.—
20	1.952 s.—
	1.942
21	1.944 s.—
22	1.951 s.—
23	1.940 s.—
24	1.939 s.—
25	1.937 s.
26	1.946 s.
27	1.943 s.
28	1.941 s.—
29	1.940 s.—
30	1.943 s.—
31	1.942 s.—
	1.942
June 1	1.938 u.+
2	1.942 u.+
3	1.941 u.+
4	1.940 u.+
5	1.949 u.+
6	1.946 u.+
7	1.951 s.—
8	1.941 s.
9	1.944 u.+
10	1.954 u.+
	1.945
11	1.951 u.+
12	1.944 u.+
13	1.942 s.—
14	1.946 s.—

TABLE 46.—*Preferred solar-constants. Daily values, 1926–1930*—Continued

Date	Solar constant and grade	Date	Solar constant and grade	Date	Solar constant and grade	Date	Solar constant and grade	Date	Solar constant and grade
1930		1930		1930		1930		1930	
June 15	1.950 s.—	July 25	1.951 s.	Sept. 3	1.942 u.+	Oct. 13	1.938 u.+	Nov. 21	1.934 u.
16	1.944 s.—	26	1.946 s.	4	1.942 u.+	14	1.939 s.—	22	1.930 u.
17	1.944 u.+	27	1.940 s.	5	1.942 u.+	15	1.940 u.+	23	1.932 u.
18	1.942 u.+	28	1.937 s.—	6	1.939 s.—	16	1.938 s.—	24	1.931 u.
19	1.944 s.—	29	1.946 s.—	7	1.938 s.—	17	1.936 s.	25	1.930 u.
20	1.940 s.	30	1.952 s.—	8	1.938 s.—	18	1.934 s.—	26	1.936 u.
		31	1.950 s.—	9	1.930 u.+	19	1.931 s.—	27	1.940 u.
	1.944			10	1.929 u.+	20	1.933 s.—	28	1.941 u.
			1.946					29	1.936 u.
21	1.940 s.				1.939		1.937	30	1.941 u.
22	1.936 s.	Aug. 1	1.946 s.—						
23	1.942 s.	2	1.944 u.+	11	1.927 s.—				1.935
24	1.947 s.	3	1.942 s.	12	1.933 u.+	21	1.939 s.—		
25	1.941 s.	4	1.942 u.+	13	1.937 u.	22	1.938 u.+	Dec. 1	1.938 u.+
26	1.937 s.	5	1.942 u.+	14	1.926 u.+	23	1.936 s.	2	1.938 u.
27	1.934 s.	6	1.942 u.+	15	1.930 u.+	24	1.939 s.—	3	1.942 u.
28	1.938 s.	7	1.942 u.+	16	1.935 s.	25	1.937 u.+	4	1.940 u.
29	1.945 s.	8	1.946 u.+	17	1.936 u.	26	1.938 s.—	5	1.938 u.
30	1.943 s.	9	1.950 s.—	18	1.938 u.	27	1.939 s.	6	1.941 u.
		10	1.947 s.—	19	1.940 u.	28	1.937 s.	7	1.942 u.
	1.940			20	1.942 u.	29	1.935 s.—	8	1.941 u.
			1.944			30	1.936 u.+	9	1.943 u.+
July 1	1.951 s.				1.934	31	1.935 u.+	10	1.940 u.+
2	1.945 s.	11	1.944 s.						
3	1.941 s.	12	1.946 s.—	21	1.944 u.		1.938		1.940
4	1.937 s.	13	1.950 s.—	22	1.946 u.+				
5	1.935 s.	14	1.944 u.+	23	1.948 u.	Nov. 1	1.939 s.	11	1.943 u.
6	1.941 s.	15	1.946 s.—	24	1.946 s.	2	1.940 s.—	12	1.945 u.
7	1.945 s.—	16	1.947 s.—	25	1.936 s.—	3	1.935 s.—	13	1.945 u.
8	1.948 u.+	17	1.945 u.+	26	1.941 s.—	4	1.933 s.—	14	1.946 u.
9	1.952 s.—	18	1.942 u.+	27	1.934 u.	5	1.937 u.+	15	1.944 u.
10	1.955 s.	19	1.939 u.+	28	1.938 u.	6	1.943 s.—	16	1.945 u.
		20	1.938 u.+	29	1.940 s.—	7	1.946 u.+	17	1.942 u.
	1.944			30	1.936 s.	8	1.939 u.+	18	1.940 u.
			1.944			9	1.935 u.+	19	1.939 u.
11	1.949 s.				1.941	10	1.938 u.+	20	1.937 u.
12	1.950 s.—	21	1.935 s.						
13	1.952 s.	22	1.940 s.—	Oct. 1	1.940 s.—				1.943
14	1.954 u.+	23	1.934 s.—	2	1.942 s.—		1.938		
15	1.955 u.+	24	1.940 s.—	3	1.942 s.			21	1.938 u.
16	1.951 s.—	25	1.941 s.—	4	1.938 s.—	11	1.938 s.—	22	1.935 u.
17	1.951 s.—	26	1.946 s.—	5	1.931 s.	12	1.940 s.	23	1.936 u.
18	1.950 u.+	27	1.947 s.	6	1.937 s.	13	1.939 s.—	24	1.938 u.
19	1.945 s.	28	1.944 s.—	7	1.934 s.—	14	1.936 s.	25	1.938 u.
20	1.945 s.	29	1.942 s.—	8	1.930 s.—	15	1.939 u.+	26	1.942 u.
		30	1.944 s.	9	1.935 s.—	16	1.939 u.	27	1.945 u.
	1.950	31	1.939 s.	10	1.939 u.+	17	1.940 u.	28	1.940 u.
						18	1.942 u.	29	1.940 u.
21	1.944 s.—		1.941		1.937	19	1.943 u.	30	1.942 u.
22	1.941 s.—					20	1.936 u.	31	------
23	1.946 s.	Sept. 1	1.945 u.+	11	1.940 u.+				
24	1.948 s.	2	1.947 u.+	12	1.940 s.—		1.939		1.939

TABLE 47.—*Preferred solar constants. Ten-day mean values. Collected and adjusted from Mount Harqua Hala values and Tables 31 and 46*

Date (decade)		1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Jan.	1	1.968	1.964	1.938	1.934	1.936	1.945	1.939	1.940	1.937	1.929	1.935
	2	1.967	1.956	1.945	1.924	1.940	1.939	1.940	1.939	1.932	1.933	1.938
	3	1.959	1.950	1.948	1.918	1.941	1.947	1.934	1.937	1.937	1.932	1.936
Feb.	1	1.958	1.942	1.944	1.925	1.936	1.941	1.935	1.939	1.944	1.933	1.934
	2	1.954	1.954	1.949	1.934	1.935	1.949	1.941	1.944	1.940	1.927	1.940
	3	1.956	1.954	1.948	(1.915)	1.937	1.940	1.930	1.942	1.941	1.930	1.943
Mar.	1	1.959	1.954	1.947	1.925	1.944	1.941	1.938	1.936	1.947	1.929	1.940
	2	1.948	1.939	1.941	1.930	1.941	1.936	1.939	1.943	1.946	1.930	1.937
	3	1.932	1.942	1.932	1.930	1.939	1.941	1.934	1.943	1.945	1.931	1.939
Apr.	1	1.948	1.949	1.930	1.933	1.939	1.945	1.930	1.944	1.943	1.932	1.941
	2	1.956	1.945	1.930	1.925	1.943	1.950	1.935	1.947	1.939	1.940	1.938
	3	1.952	1.946	1.925	1.931	1.944	1.946	1.940	1.945	1.942	1.937	1.939
May	1	1.950	1.950	1.923	1.927	1.943	1.946	1.938	1.946	1.942	1.938	1.942
	2	1.961	1.949	1.932	1.930	1.946	1.950	1.938	1.942	1.949	1.934	1.942
	3	1.950	1.950	1.924	1.934	1.947	1.954	1.943	1.945	1.946	1.935	1.942
June	1	1.943	1.927	1.920	1.918	1.951	1.943	1.939	1.950	1.946	1.935	1.945
	2	1.934	1.939	1.915	1.932	1.953	1.943	1.945	1.944	1.951	1.932	1.944
	3	1.938	1.936	1.912	1.932	1.953	1.948	1.941	1.945	1.945	1.932	1.940
July	1	1.945	1.952	1.900	1.934	1.946	1.952	1.941	1.948	1.943	1.933	1.944
	2	1.940	1.953	1.913	1.928	1.950	1.954	1.944	1.945	1.939	1.932	1.950
	3	1.951	1.948	1.923	1.944	1.943	1.947	1.941	1.946	1.940	1.934	1.946
Aug.	1	1.930	1.944	1.917	1.942	1.950	1.949	1.943	1.943	1.941	1.931	1.944
	2	1.927	1.957	1.919	1.940	1.940	1.941	1.941	1.940	1.934	1.932	1.944
	3	1.932	1.937	1.921	1.941	1.930	1.942	1.942	1.942	1.938	1.930	1.941
Sept.	1	1.951	1.950	1.921	1.945	1.941	1.956	1.941	1.941	1.941	1.928	1.939
	2	1.944	1.957	(1.915)	1.943	1.950	1.946	1.938	1.941	1.935	1.928	1.934
	3	1.944	1.950	1.919	1.940	1.946	1.950	1.943	1.948	1.923	1.932	1.941
Oct.	1	1.942	1.955	1.926	1.942	1.950	1.942	1.936	1.945	1.929	1.931	1.937
	2	1.951	1.961	1.921	1.942	1.950	1.949	1.937	1.943	1.932	1.933	1.937
	3	1.938	1.953	1.914	1.939	1.949	1.946	1.931	1.941	1.927	1.930	1.938
Nov.	1	1.952	1.958	1.928	1.934	1.947	1.944	1.932	1.943	1.925	1.932	1.938
	2	1.948	1.952	1.925	1.943	1.949	1.948	1.930	1.943	1.929	1.935	1.939
	3	1.943	1.955	1.920	1.941	1.944	1.944	1.932	1.943	1.930	1.940	1.935
Dec.	1	1.957	1.953	1.925	1.942	1.942	1.944	1.935	1.944	1.929	1.941	1.940
	2	1.957	1.950	1.922	1.940	1.947	1.945	1.934	1.938	1.926	1.939	1.943
	3	1.949	1.948	1.930	1.922	1.939	1.946	1.935	1.938	1.932	1.939	1.939

Appendix

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[1] Doctor Abbot has become convinced by private correspondence with Doctor Simpson that the method of computing the atmospheric radiation to space employed in this paper is inapplicable. He now regards the close numerical agreement he reached with Doctor Simpson in the general results as fortuitous. Three fatal objections lie against the procedure employed. First, the distribution of water vapor in the atmosphere is not known well enough. Second, the absorption of water vapor is a line absorption, and the coefficients observed by Mr. Fowle are not fairly applicable in the way used. Third, the coefficients were not observed by Mr. Fowle beyond 15 microns, and for this purpose their lack can not be supplied.

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